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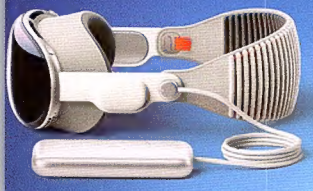

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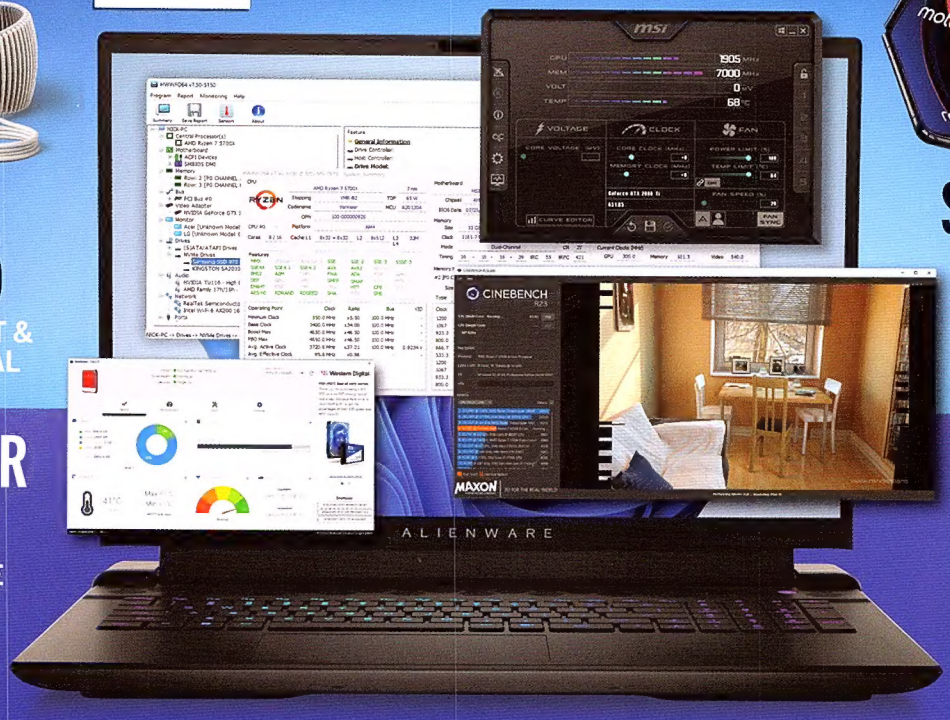

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COMPLETE GUIDE TO SETTING UP LINUX ON AN OLD PC

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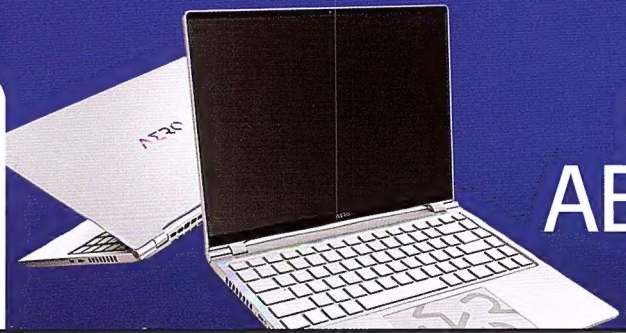

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EDITORIAL

WHAT'S INSIDE *APC*

EDITORIAL

The Q3 gaming good times

Forget Xmas, September's where it's at

BEN MANSILL
Still can't rocket jump like a pro.

Book some annual leave and exploit your accumulated sick days – it's time to play the best games you'll probably see all year. While Christmas is the traditional time for publishers to release the blockbusters, Q3 this year is an incredibly rich mother lode of games you really don't want to miss.

Right now the team is heavily addicted to *Baldur's Gate 3* – at least, those of us that still haven't had their fill of *Diablo IV*. This RPG is so good it's being used as a poster child to guilt the rest of the gaming industry into doing better. Which is of course terribly unfair. *BG3* has been in development for six years, and in early access for an astonishing three years. All plenty of time to make it perfect. If you want a truly gobsmacking open world with characters, stories and intricately detailed minutiae, you will not be disappointed.

BG3 is the sort of game you can play for a year. But what to do when *Starfield* is released? Which is right now, as you read this. Anyone that's fallen deeply into *Oblivion* or *Skyrim* knows that this, too, will be a game for the very long term. Both are RPGs, but will be very different gaming experiences, with the first-person visceral reality of *Starfield* appealing to those that don't fancy the overview tactical stylings of *BG3*. Many will attempt to play both, I sure will.

> "I've been slacking off on my *BG3*ing lately all thanks to the remastered *Quake* and *Quake 2* games. If you were gaming when the originals were released it's damn near impossible to resist having a go at these now."

But I've been slacking off on my *BG3*ing lately, all thanks to the remastered *Quake* and *Quake 2* games. If you were gaming when the originals were released it's damn near impossible to resist having a go at these now. *Quake 2* in particular is just astonishing and is indisputably the new benchmark for remastering older titles. Besides having the original game plus two mission packs all enhanced for 4K and widescreen, and with new textures and lighting, there's devilishly sharp new enemy AI that makes it oh so fresh – there's also an entirely new mission Pack *'Call of the Machine'* that could well be a 5 star stand-alone game.

And if you want something less AAA but equally cool, check out *Dave the Diver*. We have a review of this escapist delight on page 104. Like the *Quakes*, this one is easy to get into immediately and is nowhere near as intimidating as *BG3* or *Starfield*. It's a golden gaming time, people, have some fun ☺

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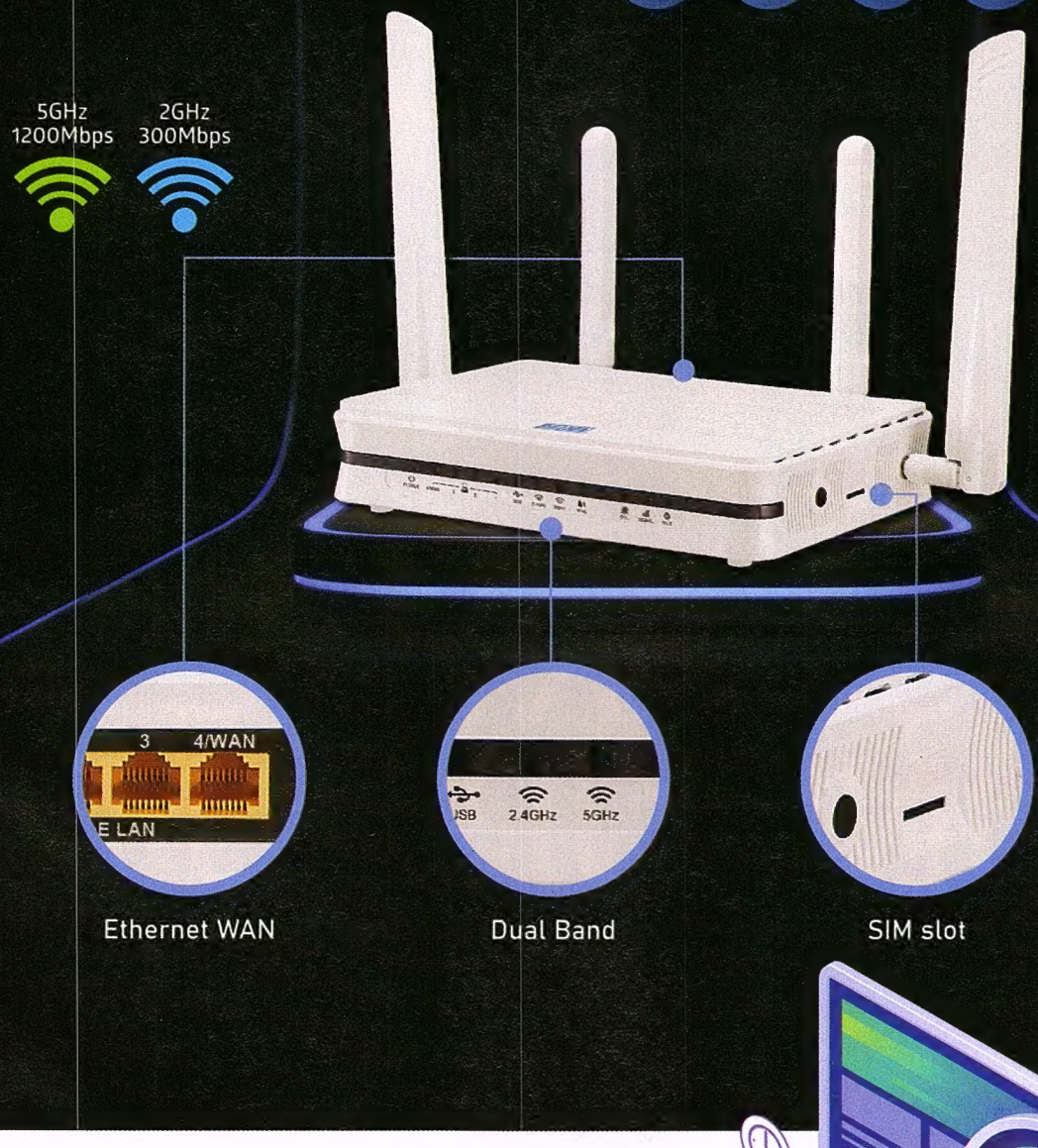

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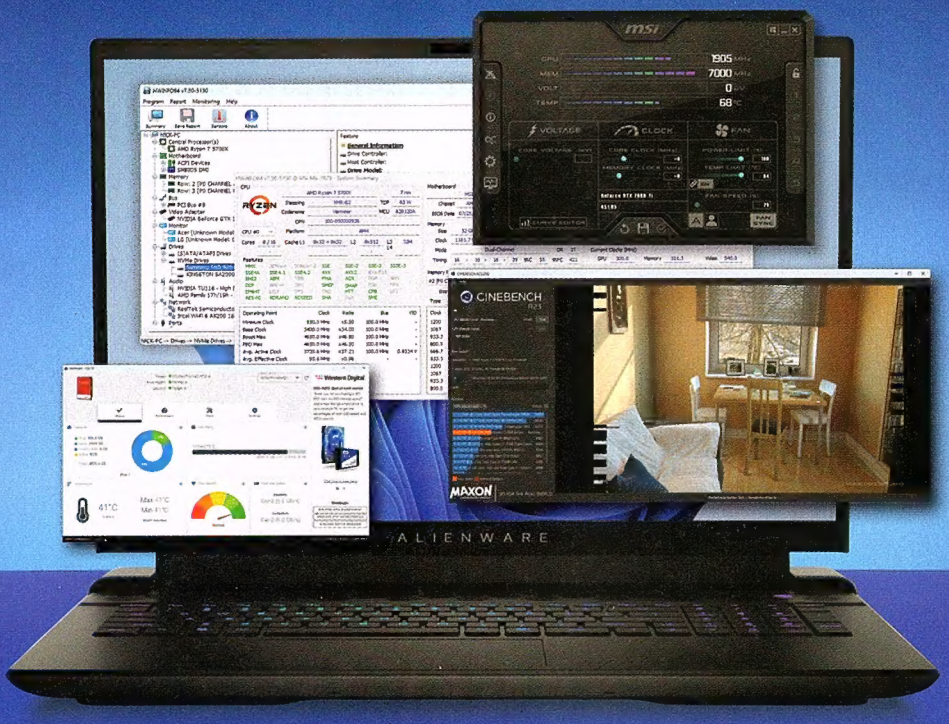

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HOW WE DO IT

Inside *APC*

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.

"Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage."

APC is Australia's oldest consumer technology magazine – having been consistently in print for over forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

UPDATED FOR 2023

apc TESTBED

The current APC testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

CPU	Intel Core i9 12900K
Motherboard	Asus Maximus Z690 Apex
Graphics Card	Nvidia GeForce RTX 4090 Founders Edition
RAM	2x16GB G.Skill Trident Z5 DDR5-6000
Power Supply	Corsair AX1000
Storage	Seagate Firecuda 530 2TB
Case	Thermaltake Core P8
Cooling	Cooler Master Flux PL360 AIO
Operating system	Windows 11 Pro 22H2

apc AWARDS

apc EDITOR'S CHOICE

APC EDITOR'S CHOICE

When a product scores 4.5 out of 5, it carries the Editor's Choice Award. These are products that exceed expectations and deliver a quality experience up there with the very best.

apc HIGHLY RECOMMENDED

APC HIGHLY RECOMMENDED

You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.

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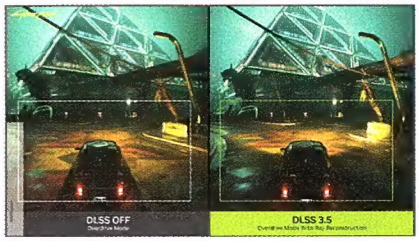

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NVIDIA'S DLSS 3.5 UPDATE WILL IMPROVE RAY TRACING AND PERFORMANCE

BRINGING AI TO BEAR ON THOSE NOISY TRACED RAYS.

Nvidia has announced a gorgeous new update to its Deep Learning Super Sampling technology. DLSS 3.5 will drop in the next few months and promises to improve both the look of a final ray traced scene as well as deliver a welcome little performance bump, too. It's going to be available to anyone using an RTX generation GPU. Effectively what it's doing is replacing the denoisers in the graphics pipeline with this AI-powered Ray Reconstruction element that will work alongside the traditional Super Resolution upscaling workflow. It's this removal of the standard denoisers which is delivering the slight performance increase, but it's the improvement in overall image fidelity which is the starkest difference between the current method and DLSS 3.5.

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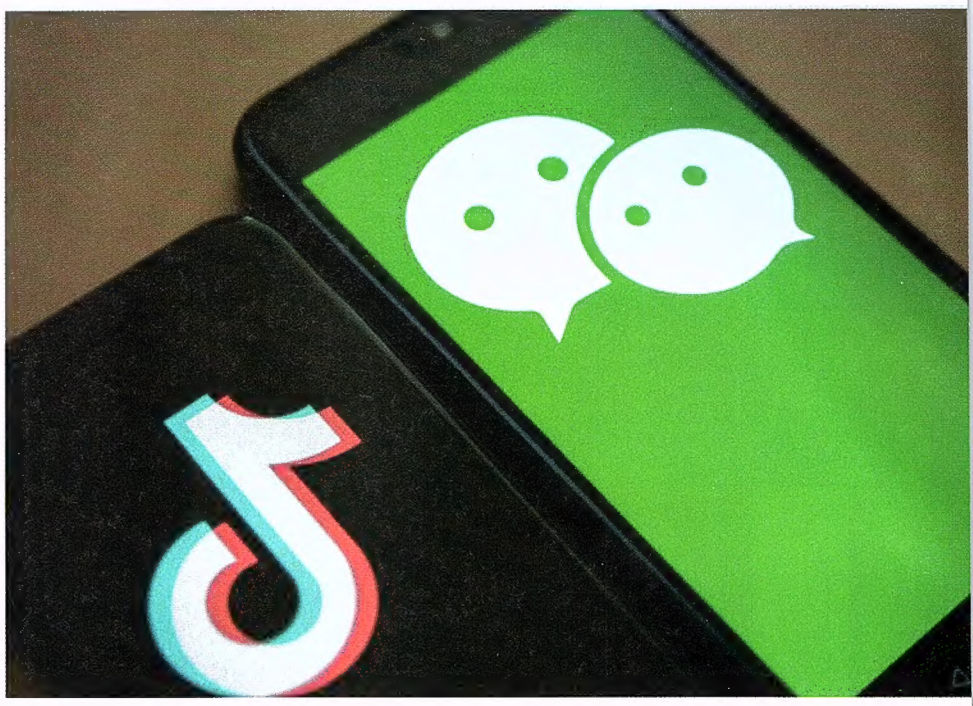
ARC A380 150MHZ BOOST WITH LATEST DRIVER

INTEL FIGURED OUT THE ARC A380 CAN HANDLE HIGHER CLOCK SPEEDS.

Intel's latest driver release (version 31.0.101.4644) has unexpectedly increased GPU performance, for one of its GPUs, at least. According to a *Neowin* post, the new driver update is bundled with a hidden firmware update for the Arc A380 that boosts GPU clock speeds by an impressive 150MHz, going from a flat 2,000MHz clock speed by default to 2,150MHz with the firmware update. A 150MHz clock speed upgrade is no joke and is a substantial jump from a mere firmware update. In the world of modern GPU overclocking, getting a stable 150MHz core offset would be a very good result on any of Nvidia's recent GPUs. Most Nvidia GPUs usually top out anywhere between 100MHz to 200MHz on the overclock front, depending on GPU temperatures and silicon quality.



SECURITY

Government WeChat ban recommended

Australian Senate committee warns TikTok and WeChat could be the country's biggest security risks.

In the wake of an existing ban on TikTok, an Australian Senate committee has recommended WeChat be banned from all Australian government devices. The move comes amid concerns that WeChat poses national and personal security risks and suggests a nationwide ban on both apps may be considered.

According to reporting by the *Associated Press*, James Paterson, chair of the Committee on Foreign Interference through Social Media, said the report's recommendations would make Australia a more difficult target for the serious foreign interference risks that he says the nation faces.

"It tackles both the problems posed by authoritarian-headquartered social media platforms like TikTok and WeChat and Western-headquartered social media platforms being weaponised by the actions of authoritarian governments including Facebook, YouTube and Twitter," Paterson told reporters.

WeChat is owned by Tencent. It's a hugely popular Chinese app. It functions as a social media app, payment gateway and gaming platform on top of its core messaging functionality. Tencent is well known for its gaming investments and subsidiaries, including Riot Games and Epic Games. TikTok is owned by ByteDance, a Beijing based company.

As Tencent and ByteDance are Chinese headquartered companies, they fall under the purview of the Chinese government, which means apps are subject to censorship protocols and the requirement to share data with Chinese authorities. These provisions make foreign governments understandably nervous.

> "Australia is far from the only country to consider or implement bans. TikTok is banned from government devices in many European countries, a majority of US states, and Canada among others."

Australia is far from the only country to consider or implement bans. TikTok is banned from government devices in many European countries, a majority of US states, and Canada among others. It's completely banned in India.

The relationship between Australia and China is generally one of engagement and co-operation, but in recent years has become more volatile. China is Australia's largest trading partner, but concerns over its influence in Australian domestic affairs are rising. As China's global influence rises, and its tech sector continues to develop, it's hard to see anything other than a rise in tensions with the west. The increased banning of Chinese software is just one part of the developing technology conflict. Efforts to shore up domestic chip production and restrict sales of high tech items to China are just part of what is developing into a 21st century cold war. That's if we're not there already.

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© Dell

Dell fined $10M for exaggerating discounts

Fine comes in the wake of compensation for Australian customers earlier this year.

Iconic PC maker Dell has been fined for misleading Australian customers. In August the Federal Court ordered Dell Australia to pay $10 million for making "false and misleading representations," about discounted bundled monitor prices on its website. Dell Australia, a wholly-owned subsidiary of Dell Technologies, admitted it had misled customers with its monitor offers.

Dell also admitted that statements like "Total Savings", "Includes x% off", "Discounted Price" and "Get the best price for popular accessories when purchased with this product," were misleading to customers.

More than 5,300 add-on monitors with overstated discounts were sold by Dell Australia between August 2019 and December 16, 2021.

ACCC Commissioner Liza Carver said that action was taken against Dell Australia "because consumers rely on accurate information about prices and discounts to make purchasing decisions." She also warned any company thinking about advertising discounted product prices to ensure accuracy.

Dell's fine could probably have been even bigger if it had not co-operated during the proceedings and admitted wrongdoings with regard to Australian Consumer Law.

© Liliputing

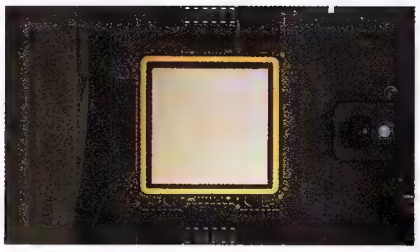
LENOVO IS WORKING ON A WINDOWS PC GAMING HANDHELD

Another Steam Deck, Asus ROG Ally competitor enters the fray.

The handheld PC gaming space is heating up, with huge success stories from both Valve's Steam Deck and Asus' ROG Ally, while Microsoft itself has tasked Xbox with improving the Windows experience on handhelds for this emerging category. Now, it seems, another major player is about to throw its weight into the mix.

According to our sources, Lenovo is working on a handheld gaming PC dubbed 'Legion Go,' and it will sport Windows 11 for maximum PC gaming compatibility.

While details are scant right now, we understand this will sport AMD's new Phoenix processors, which the chip firm describes as ultra-thin, focused on gaming, AI, and graphics for ultrabooks. The fact the Legion Go will sport Ryzen chips pretty much guarantees that this is a Windows PC gaming handheld, as part of Lenovo's popular gaming "Legion" brand.



APPLE'S M3 CHIPS EXPECTED TO GET MAJOR UPGRADES

M3 ULTRA TO HAVE UP TO 32 CORES, UP TO 80 GPU CLUSTERS.

Apple's M3-series system-on-chips are expected to get a major performance upgrade compared to predecessors.

The company's upcoming base M3 is expected to retain eight general-purpose cores (four high-performance and four energy-efficient cores) and an integrated GPU with up to 10 clusters. The M3 Pro is projected to get 14 general-purpose cores (eight performance cores, six efficiency cores) in its top-end configuration, but its range-topping GPU will get 20 clusters, up from 19 clusters in M2 Pro. The M3 Max SoC is rumoured to get 16 general purpose cores (12 performance cores and four energy-efficient cores) as well as up to 40 GPU clusters. The M3 Ultra system-in-package consisting of two M3 Max chips will therefore get 32 CPU cores and up to 80 GPU clusters.

AMD'S ANSWER TO NVIDIA'S FRAME GEN GRAPHICS TECH COMING SOON

FSR 3 AND FLUID MOTION FRAME TECH COULD ARRIVE JUST IN TIME FOR AMD'S NEW GPUS.

AMD's FSR 3 and Fluid Motion Frames technology could finally appear as soon as this month. Indications are that AMD will finally launch FSR 3 with Fluid Motion in September to tie in with new RDNA 3 GPUs. AMD's head honcho, Lisa Su, recently confirmed that new RDNA 3 GPUs are imminent. We're expecting confirmation of at least the Radeon RX 7800 XT to launch by early September and maybe the 7700 XT, too.

While AMD offers reasonably competitive resolution scaling technology in FSR 3, it currently lacks a direct alternative to Nvidia's Frame Generation. The latter uses AI-enhanced algorithms to create whole new frames that are inserted in between fully GPU rendered frames. ■

TECH BRIEF

Science teams race to validate superconductor breakthrough

The race is on for "watershed moment for humanity".

Is LK-99 is a black swan? A worldwide race to validate whether the material is a room temperature, ambient-pressure superconductor is still ongoing. Beyond the initial coverage rush, well over a dozen research teams are working at breakneck speed to validate the original South Korean claims around the copper-lead-apatite compound.

According to a real-time Wikipedia live-tracker, a total of 16 separate teams are currently working on the replication efforts as we speak – 16 that we know of, anyway. Considering the claims that LK-99 has already been synthesised over a Russian kitchen sink, you can bet that a number of efforts all across the world are underway to crack LK-99. From government agencies to corporations and even individuals, the race is on.

The results are hit and miss: The scientific community is having difficulty verifying both halves of the superconducting equation. *Tom's Hardware* reported that a Chinese team with the Physics Department of Southeast University in Nanjing, China, have measured zero electrical resistance. But research teams worldwide are repeatedly failing to verify both halves of the superconductor equation – both zero electrical resistance and magnetic levitation due to the Meissner effect. Is it a breakthrough, or just bad science? Here's everything you need to know: the good, bad, and ugly of LK-99.

The LK-99 superconductor so far

There's no consensus at present as to whether LK-99 is the be-all, end-all of superconductors. Replication efforts are underway, and institutions are gathering around the issue. Currently, there are ten different teams confirmed to be working on the matter with actual physical experiments, and six teams conducting theoretical studies.

The Korean Society of Superconductivity and Cryogenics (KSSC) has instituted a verification committee with the goal of scientifically assessing the original experiment. According to a machine learning translation of the proceedings the initial assessment by KSSC is that the available research (both the rogue first paper and the "official" second one), as well as public data on LK-99, doesn't support the claim that LK-99 can be called a room temperature superconductor.

These first conclusions spurred the Quantum Energy Research Institute to respond by saying it would provide the committee with a sample, with which it could verify that LK-99 is indeed a room-temperature superconductor. Considering the volume of suspected

"There's no consensus at present as to whether LK-99 is the be-all, end-all of superconductors. Replication efforts are underway, and institutions are gathering around the issue."

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fraud in the history of superconductor announcements, it pays to be careful.

In the meantime, the Chinese researchers that claimed yesterday to have replicated superconductivity have published their paper to Arxiv, the pre-print repository whose servers must be getting slightly more hammered than usual. There, they write in more detail how they used solid-state synthesis to produce a polycrystalline sample of LK-99 ($Pb_{10-x}Cu_x(PO_4)_6O$). They also verified high-temperature superconductivity that was slightly worse than the original sample at above 100 Kelvin (-173º C) compared with the 110 Kelvin (-163 ºC) verified in the original Korean experiment.

The words they use in describing their conclusion are telling: LK-99 "is a possible candidate for searching high-temperature superconductors." If that's it, then it seems that LK-99, as they verified it (and remember that the synthetisation process was badly documented and has shown extreme variability), actually isn't a room-temperature superconductor.

Another Chinese research team with the Shenyang National Laboratory for Materials Science led by Dr. Junwen Lai et al published extremely similar results on August 1st. It seems room temperature confirmation has so far eluded any and all attempts at replication.

That LK-99 presents superconduction at relatively handleable (if very low) temperatures seems to be a fact, but questions still abound.

What's next?

Experimentation and sciency stuff will keep happening until someone has either validated the (then Nobel-winning) Korean team's original results, or partially validated them... or until crushing defeat as the claims are disproven. You can rest assured that everyone in the superconductor realm of research is paying close attention to LK-99 right now, and even if it ends up being a failure, that, too, is part of the scientific process.

But in general, there seem to be three distinct ways the LK-99 process can go: One, we've found a true ambient-temperature, zero-resistance superconductor. If that is true, it'll take years of work to better understand this material

Andrew Côté · Aug 1, 2023
@Andercot · Follow
First claimed successful replication of LK-99
Accomplished by a team at the Huazhong University of Science and Technology and posted 30 minutes ago.
Why this is evidence:
The LK-99 flake slightly levitates for both orientations of the magnetic field, meaning it is not simply a...
Watch on Twitter
The toothpick is pointing to the material we obtained. this black dot.
Andrew Côté
@Andercot · Follow
If it wasn't clear why this is a big deal, if successful LK-99 would be a watershed moment for humanity easily on-par with invention of the transistor.

The excitement surrounding LK-99 is at maximum, because it really could change the world if its promises turn out to be true.

before it actually revolutionises human life. Considering the relative cheapness and abundance of the two key ingredients – lanarkite (Pb_2SO_5) and copper phosphide (Cu_3P) – it's likely we'll get some usage out of it as a superconductor, even if synthetisation yields don't improve much. And the synthetisation process (at least, at this likely crude stage) is relatively simple.

It wouldn't take that many flakes of LK-99 to revolutionise the sensor industry, opening up all kinds of doors in the field of medicine, microelectronics, cybernetics, and Brain-Computer Interface (BCI) designs. In this scenario, there's little doubt that with good enough yields and a better understanding of the quantum chemistry happening here, LK-99 could indeed revolutionise human life.

Another way this could go is that LK-99 is a superconductor, but not the superconductor. Let's assume it's confirmed to be a high-ish temperature superconductor (due to superconductance being reported around the 110 Kelvin mark). That's still an incredible win. 110 Kelvin [-163 ºC] does bring LK-99's superconductor utility down to liquid Nitrogen-required levels (LN2) instead of the much more expensive and difficult-to-handle liquid Helium (He).

A turning point

That alone brings room-scale superconductance into the equation, which is already enough to bring superconductors to MRI machines and other medium-scale applications. Humanity would still find a number of applications for it, as we've done for even YBCO, the first material discovered to be a superconductor. YBCO's main issue is that it becomes superconductive only at about 93K (- 180 ºC). It's also a very difficult material to refine (its yields are extremely low), but we've already tamed it into a subset of its possible applications. And expanded applications, or iterative improvement, is what it's all about.

Another way this could go might become a parallel to what happened with cold fusion in 1989. Then, a botched experiment yielded erroneous results, catapulting the scientific community toward a wild, frantic goose chase in an attempt to replicate the results. There too, the discovery was swiftly followed by several tentative or partial announcements of replication, which tapered off and started being retracted as time passed. In the end, cold fusion and the fuss about it originated from a failed moment in science, and the scientific community is now pretty agreed upon that.

But notice the possible similarities...

■ **Francisco Pires**

© Andrew Cote, Shutterstock

END USER

Baldur's Gate 3 is too good

Larian's ambitious RPG has begged the question: can other studios compete?

© Larian Studios

Shaun is an Australian editor for *PC Gamer*, *GamesRadar* and *PLAY*, and writes for *APC*, *TechRadar* and more.

Is *Baldur's Gate* 3 too good? That was a matter sincerely debated in August when, to the surprise of everyone except CRPG enthusiasts, Larian's new fantasy game hit the big time with critics and mainstream audiences alike. The discussion was triggered by game developer and writer Xalavier Nelson Jr., who correctly pointed out in a tweet that the scale and technical ambition of *Baldur's Gate* 3 is not likely to become a new "baseline" for what players can expect from RPGs.

It's really more of an anomaly: Larian is an independent studio that has iterated both its artistic and technological skills over nearly 30 years and on the back of some recent successes in the genre. The studio is both independent and wealthy, thanks to the success of its *Divinity* series. It has specialised in prickly, not-for-general-consumption CRPGs for more than a decade, amassing capital in that most unusual of ways: by sticking to an artistic goal and not compromising. It is extremely well-placed to develop a big-budget albeit niche videogame like *Baldur's Gate* 3: loaded with cash, abundant in ideas, and not beholden to a publisher.

The attitude Nelson Jr was preempting (he tweeted in the weeks leading to *BG3*'s release) is a common one in games, which still suffers from an arms race mentality that has been – in a mainstream sense – irrelevant for most of this century. In the '90s, at a time when software was evolving at a blinding pace, a studio releasing a *Wolfenstein* clone in a post-*Doom* world was going to struggle: the advancement between those two landmark games is obvious to anyone, and yet only a year separates them. Nowadays, with most games developed for console platforms that stay on the market for nearing a decade, the pace has inevitably slowed dramatically.

Fewer than a dozen people worked on *Wolfenstein* and *Doom*; nowadays, a team of mere hundreds working on a big high-profile videogame is small fry. The scale of the games industry and games themselves have grown to an extent almost inconceivable back in 1993. Nelson Jr. is right when he implies that independent studios won't be able to match what *Baldur's Gate* 3 has achieved any time soon. What's more interesting is why the likes of Ubisoft, or Blizzard, won't be able to either.

Interesting, though not surprising: it's because Ubisoft and Activision-Blizzard have shareholders to report to. One cannot spend nearly a decade developing a complex, intimidating niche style of RPG without meeting serious questions around "where's the post-launch revenue stream" or "why would Joe Fortnite fork out $100 for this instead of a pack of DeadMau5-themed digital jorts"? To put it bluntly: developing a big budget CRPG, in the eyes of the money bogeymen, is foolish. Except, however, when it's not!

Nelson Jr.'s comments faced inevitable blowback across the internet: why shouldn't other studios work harder if the bar has been raised? Seen from the point of view of consumer entitlement the question seems a bit naive, but as a question served to a medium, it suddenly seems like a decent one. Why shouldn't *Baldur's Gate* 3 enforce a new baseline in the RPG space? The fact is that it's really just impossible: unless another independent studio has the success of Larian, coupled with the same passion and vision, games such as this are not going to suddenly release every other year like, say, an open world collectathon.

Shaun Prescott ■

Green PC tech

Ocean-bound plastic, cooking oil and coffee grounds: HP's new PCs are greener tech done right.

Tech companies like to talk about how they're going to play an integral role in shaping a better future, but for an industry at the forefront of industrial capabilities, there really hasn't been much development in environmentally friendly products... at least not in terms of obvious company wide shifts.

I was recently at HP's Future Ready Conference in Tokyo where the company was keen to highlight its sustainability goals, giving us an insight into what environmentally-conscious tech looks like. As someone with a Masters degree in Environmental Management, this is a topic close to my heart and, while it's encouraging to hear that more and more tech companies are trying to go green, a lot of it ends up seeming like marketing material rather than meaningful progress.

So what exactly is different about HP's eco-friendly goals and products that haven't been seen before? Well, firstly, it's got some of the most ambitious carbon emissions goals in the industry: A benchmark that pushes the company to be 5, 10 or even 20 years ahead of competitors in transitioning to less impactful products. But it's not just carbon emissions, HP is also leading the tech space in product design that incorporates recycled materials, using less harmful manufacturing processes wherever possible and thinking about the full lifecycle of products in ways that reduce waste and promote digital equity.

HP announced its intentions to be carbon neutral by 2025 back in 2021, a plan that extends to an even more ambitious pledge of net zero carbon emissions by 2040. As far as carbon emissions go, this is the most aggressive pledge from any of the large-scale tech companies building consumer laptops.

> "HP is also leading the tech space in product design that incorporates recycled materials"

HP's 2023 launch of what it calls the "the World's most sustainable PC portfolio" in the US which includes a new laptop that offers third party certification for including "more recycled content used in more components than any other competitor PC in its class".

The HP 14" Laptop Eco Edition is currently only available in the US, but the product is slated for global launch according to HP, even though there's no official timeline yet. Personally, I'm pretty excited by the prospect of a device that contains 50 percent recycled aluminium, 25 percent system level recycled plastics, 100 percent water-based keyboard paint and EPEAT (Electronic Product Environmental Assessment Tool) Gold certification.

Even if you do get one of the HP 14" Laptop Eco Edition laptops on a carbon neutral and circular plan there's still going to be processors using harmful chemicals in manufacturing, there's still large chunks of virgin plastics and rare earth minerals needed for performance and robustness, carbon is currently still emitted in the creation and there will be materials lost when it's broken down (if it doesn't get a second life after you're done with it)... but it feels like the first time a laptop with a significantly smaller environmental impact has ever been a genuine option for consumers. **Joel Burgess**

Joel is one of the senior journalists on *APC* magazine and apart from being the resident laptop, monitor and fitness tech geek, he's also pretty into surfing his local Sydney beach breaks when he's not in front of a screen.

TECH TALK

Nvidia is playing games

Nvidia RTX 4060 Ti 16GB launches in stealth mode.

Jarrod Walton
Jarrod has been described as an AI by people he meets at parties.

With all the fanfare of a beginning band student, Nvidia 'launched' the RTX 4060 Ti 16GB on July 18. Except, much like with a few other less desirable GPUs in previous years, Nvidia opted not to sample media and press with review hardware.

Even worse, while listings showed up as planned, everything showed "auto-notify" or "back ordered" for at least the next week. Cards are finally starting to be available, but reviews are few and far between.

You might think it's no big deal, but Nvidia's RTX 40-series graphics cards have received a lot of negative press over the past few months. The consensus tends to be that while the RTX 4090 is an excellent halo product, everything else has been cut back too far, with prices that are out of touch with the current market conditions. It's almost like all the planning and design of Ada Lovelace happened during a time when you couldn't find any graphics card in stock at a reasonable price. As we've noted, the various product tiers do generally outperform their predecessors, so the RTX 4060 Ti, for example, beats the previous generation RTX 3060 Ti, but the differences – especially when you don't factor in DLSS 3's frame-smoothing technology – are rather muted.

Another complaint is about the lack of VRAM capacity. I wrote about the VRAM topic back in the August issue, but there's a valid argument that Nvidia cut the design of most RTX 40-series GPUs too far. If we were still being plagued by cryptocurrency miners buying up all our gaming GPUs, maybe the 128-bit memory interface on the RTX 4060 and 4060 Ti would make sense. But in a post-Ethereum mining world where most cryptocoins are struggling to break even on power cost versus coin value, the reduction in raw memory bandwidth and capacity looks bad.

> "Several companies even said that given the negativity around the RTX 4060 Ti, they did not see a need to seed reviewers and influencers with hardware."

Nvidia's half-hearted answer was to release a 16GB variant of the RTX 4060 Ti. It has the same 128-bit interface, but with 2GB chips on both sides of the PCB in a clamshell configuration. How does it perform compared to the 8GB card? Nvidia's internal benchmarks show identical performance across a suite of 16 games, while in two more games it tested the 16GB card at higher settings, and thus we don't have apples to apples data points.

Several companies even said that given the negativity around the RTX 4060 Ti, they did not see a need to seed reviewers and influencers with hardware. We know there are games that can exceed 8GB of VRAM use at certain settings. Presumably, the 16GB card will do better in those games. However, it has the same compute and bandwidth as the 8GB, so there will likely be a big gap between the 4060 Ti 16GB and 4070.

Bumping up the VRAM interface and capacity one notch on each of the RTX 40-series GPUs (other than the 4090) would have gone a long way toward stemming complaints. Unfortunately, that ship likely sailed back in 2021, during the final design stages for the Ada Lovelace architecture.

Jarrod Walton ■

Top: MSI's white RTX 4060 Ti Gaming X Slim launched in July, but reviews were elusive.

TWO BITS

PCIe 5.0 SSDs are great

But they're irrelevant, for now...

In this issue, I review a Seagate FireCuda 540 PCIe 5.0 SSD (page 40). Actually, I quite like it. It's faster than the best PCIe 4.0 drives but sadly, it's a lot more expensive. At the time of writing, the 2TB 540 was priced at a whopping $589, which is in line with similar drives. But compare that to the best PCIe 4.0 drives at over $200 less, with many cheaper than that, and PCIe 5.0 SSD are clearly a very tough sell.

I said exactly the same thing when PCIe 4.0 drives launched. They were simply too expensive to recommend over good quality PCIe 3.0 drives. It's a case of history repeating. We'll all be saying the same thing in a couple of years when PCIe 6.0 drives arrive.

I'll take one popular example: The Western Digital SN850X 2TB. It's one of the best PCIe 4.0 drives, if not the best. When I reviewed it in APC issue 513, it was priced at $519. That same drive can be bought for under $300 now. If it wasn't for inflation it would probably cost even less.

It's a perfect example of the early adopter 'tax'. Though there are other circumstances involved, such as the cratering wholesale price of NAND flash, it's still unusual to see PC tech drop in price by nearly 50 percent in just a year. That's why you should not rush out and buy a PCIe 5.0 SSD today.

It's easy to recommend one of you've got an equally high end and expensive system. Some people just want the best, and more power to you! It's the reason people buy the fastest memory or spend extra on a premium tier graphics card with all the bells and whistles. Some people are happy to pay a premium.

It's great to see PC hardware set new standards. Just don't get lost in the marketing buzz. For the price if a PCIe 5.0 2TB drive, you can pick up a decent 4TB PCIe 4.0 drive. You won't notice any real-world difference unless you frequently shuffle terabytes of data. Outside of professional use cases, I'd argue consumers probably clone a drive, transfer a TB or so and then never need 12GB/s speeds again.

Here's another thought. I'd be more than happy to see PCIe 5.0 x2 drives. That'd still give you around 7,000MB/s transfer speeds, and it would hardly cost anything in terms of random performance and in/out operations per second. You could add two drives instead of just one. CPU and motherboard PCIe lane counts are limited, so unless you need to transfer 10 to 14GB/s per second (and you need very fast accompanying drives to get anywhere near that, let alone sustain it) then the peak sequential transfer speeds of the best SSD's are complete overkill.

On a positive note, I believe heat concerns have been overstated. As long as you have decent case airflow and a good quality motherboard heatsink, heat should not be an issue. Modern SSDs typically see bursts of activity. I can't imagine too many instances of needing to load the drive at 100 percent for extended periods – in the consumer space that is.

Let's see what happens in a year from now. I'd bet on ultra-fast PCIe 5.0 drives plummeting in price as much as their predecessors have, and when that happens, the best SSDs will become useful for more than just a few deep pocketed individuals.

Chris Szewczyk ■

Chris has been elbow deep in PCs since before the turn of the millennium, and he wouldn't have it any other way.

TRADE CHAT

PC parts prices are mostly back to normal

And aren't we all glad that's finally over? For now...

$289 for a decent 4TB SSD? Now that's a good deal.

Jeremy Laird
Has a black leather jacket just like Jensen's.

Tales of inflationary woe continue, but if anything, many PC component prices have been falling. Indeed, Amazon's recent Prime Day fire sale was packed with low-priced PC parts, with one predictable exception.

Perhaps the most conspicuous bargain involves storage. SSDs are pretty much being given away, with decent 512GB drives at under $50, a high-performance 1TB model like the WD SN850X for $120, and quality 2TB options for under $200.

> "Perhaps the most conspicuous bargain involves storage. SSDs are pretty much being given away, with decent 512GB drives at under $50."

I even saw a 4TB that was going for just over $289. Okay, it was an older Gen 3.0 model from TeamGroup that tops out at about 3GB/s. But outside of a few edge-case workflows, you're never going to tell the difference in experiential terms next to a Gen 4 SSD that's twice as fast on paper.

Meanwhile, 32GB of DDR5-6000 can be had for about $180. As for CPUs, $350 or so buys you something decent, like a six-core AMD Ryzen 7600. Spend a bit more, and you can have an eight-core last-gen 5800X model for under $360.

On Intel's side, $370 buys you a Core i5-12600KF. Throw in a half-decent motherboard for about $200, and you're most of the way there.

Even a decent screen is cheap. One of the best Prime Day deals I saw was an MSI 27-inch 1440p panel with 170Hz refresh for $220. Speaking of MSI, they will also do you a 32-inch 4K 60Hz panel that's perfect for productivity for $500. Samsung's M7 4K 32-inch "smart" monitor is barely any more money at $650. The M7 isn't just 4K; it has USB-C with 65W of power delivery for single cable connectivity, TV apps, mirroring support, and a remote.

But there's a catch: GPUs. Nvidia's most recent graphics card launches were both aimed at 1080p gaming, and yet the GeForce RTX 4060 Ti is priced at around $699 and the feeble RTX 4060 at $520. Nvidia's cheapest current GPU that's marketed for 1440p gaming, the RTX 4070, is $1,049. How any of that makes sense in the context of $220 1440p high-refresh monitors, I have no idea.

The closest you'll get to a GPU priced in line with current monitor tech are AMD's 6700 XT and 6750 XT boards. The former can be had now for around $530. Sadly, they won't be available for much longer, and it seems unlikely that their replacement, likely branded Radeon RX 7700 XT and expected to launch this year, will be as cheap.

To put that in further context, there was a 27-inch 1080p Asrock gaming monitor capable of 165Hz for under $200 during the Prime fire sale, but Nvidia expects you to pay four times as much for a 1080p GPU.

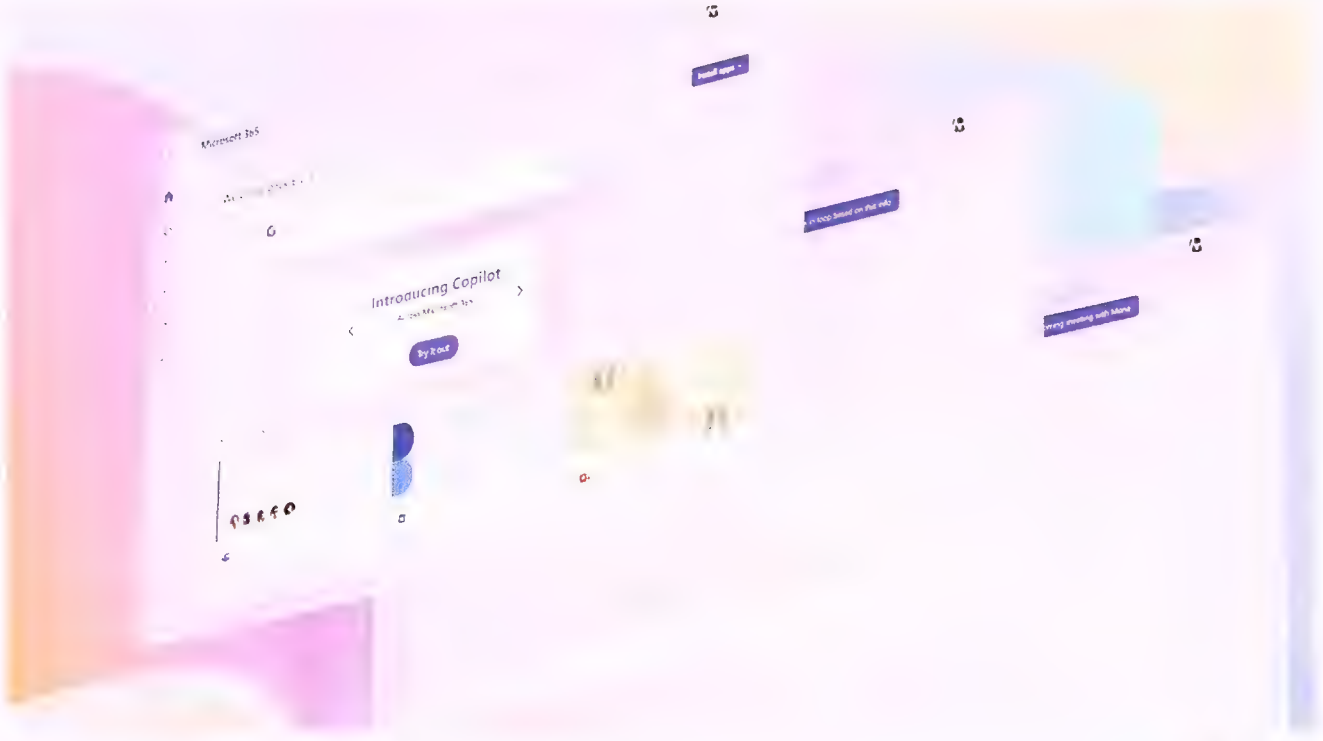
Anyway, while it's tempting to get bogged down in the narrow negative narrative involving graphics cards, the broader story is what matters. The PC has almost entirely recovered from the external shocks that sent prices spiralling, and once again there's excellent value to be had for most PC enthusiasts. Hooray.

Jeremy Laird ■

ONE MORE THING

Copilot in command

Will the AI future have us all bland, boring but beautiful?



Microsoft's announcement that it is rolling out its Copilot AI and large language model (LLM) technology into Office 365 is both thrilling and terrifying. It doesn't come cheap, of course. At US$30 (~AUD$45) per user per month, this is a significant uplift on the cost of an Office 365 E3 licence.

From a business point of view, the price is almost an irrelevance. I don't say that flippantly. I simply mean that it's easy to justify $30 of increased spend if more than this is returned to the company in terms of direct benefits in productivity, along with more indirect outcomes such as improved data mining, insight and time planning.

The one feature that causes me to pause, however, is the ability for Copilot to look at Excel data, and offer up analysis based on the content it sees. For obvious data, this could work well. Creating models, and doing analysis, is often simple, but the devil is always in the detail. Maybe Copilot can help here by offering up different models. Even better would be the ability to audit existing data and analysis, to show where errors might have occurred. An expert on your shoulder, for example.

But will this fix the underlying concern of a homogenisation of output, where everything turns into bland mush?

To see what I mean, consider that a few years ago the first line of any email became, "I hope this email finds you well", or an equivalent bland welcome. It has now become just more noise, and I'd like an AI tool to summarise and remove this stuff. But there is the risk of false positives where something important gets lost too. I can see "Copilot ate my data" become the modern version of "The dog ate my homework" as the default excuse for anything going wrong?

To top it off, Microsoft has announced a collaboration with Maybelline, the well-known cosmetics company, to incorporate the Maybelline Beauty App into Microsoft Teams. This will allow meeting attendees to adjust their personal makeup using AI, to help prevent the "morning after the night before" look. As the announcement states: "The Maybelline Beauty app in Teams uses AI-powered functionality enabled by Modiface, an augmented reality technology for the beauty industry owned by Maybelline parent company L'Oreal. Modiface AI identifies over 70 points of the users face to create a 'virtual map' that enables the seamless application of the digital filters."

I fear that this will become the default setting, just like those auto-formatted tables in Excel, and style sheets applied in Word. Anyone not having the smoothed skin effect, a touch of lip gloss, and maybe a smile make-over will quickly look out of place. And this matters in the workplace.

What has then happened to integrity, to reality? To the fundamentals of a business meeting where trust is built upon the relationships honed over time? It is great to be able to automatically translate your speech into French and Korean in real-time, for the benefit of attendees who are not native English speakers, and vice versa of course. But there are some areas where AI shouldn't be used. Unfortunately, we don't know where those boundaries are yet, and there will be much pain experienced in defining them in the coming years.

So my message to you is simple. Don't worry about how much the pig weighs, how much it costs. Worry about the lipstick.

Jon Honeyball ■

Jon Honeyball
Jon is a veteran of too many Teams meetings to count, he has no need to add virtual makeup.

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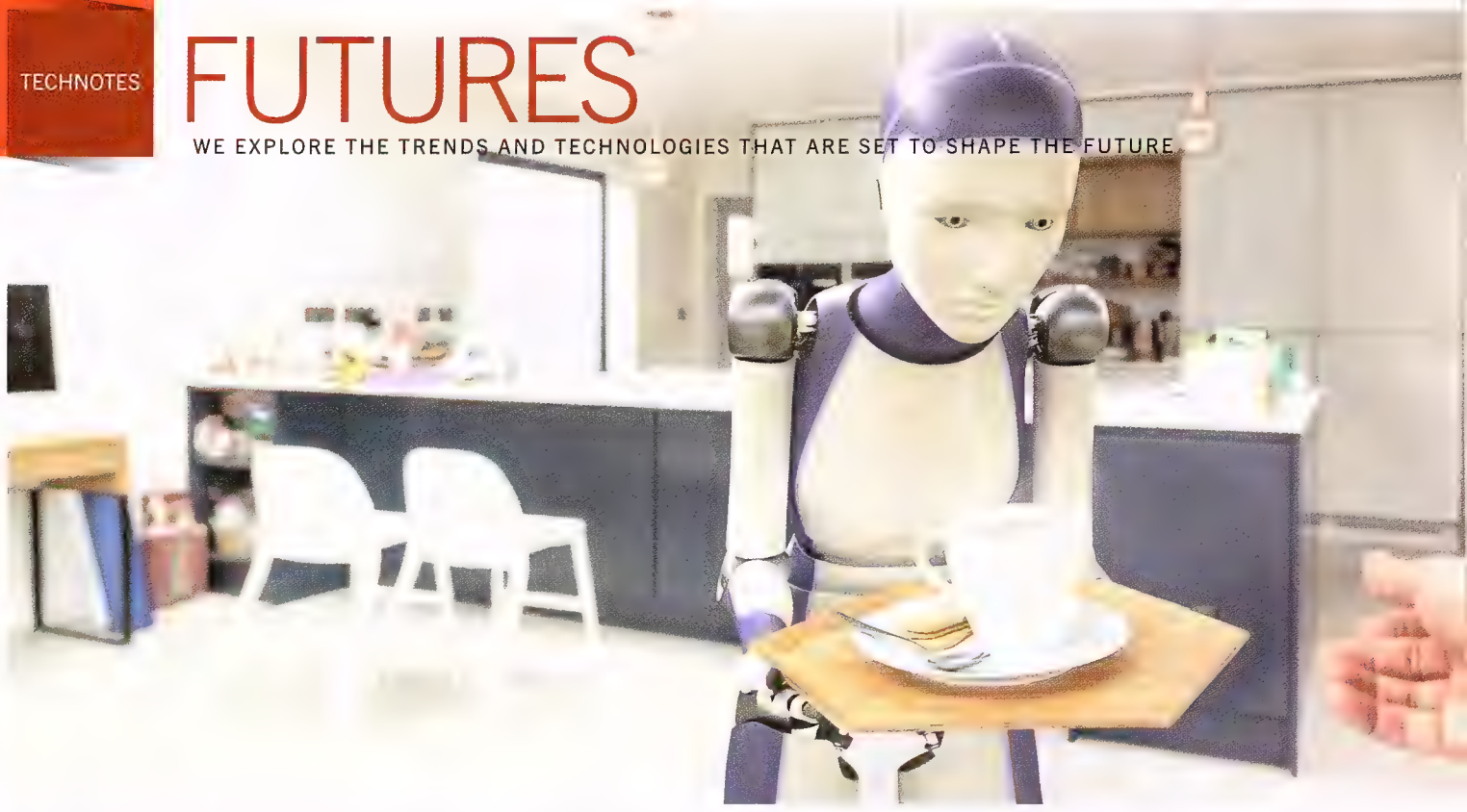
FUTURES

WE EXPLORE THE TRENDS AND TECHNOLOGIES THAT ARE SET TO SHAPE THE FUTURE



Robobutlers may never happen, but robot care workers are on their way

Do you hate loading the dishwasher enough to pay someone to do it remotely? Nicole Kobie wonders about the weird future of home robots.

Someone to make a cup of tea for you, fix dinner while you're at work and then do the dishes while you catch up on your favourite shows. This is no backwards dream of a stereotypical 1950s housewife, but the much-promised future of robot butlers.

Such robobutlers don't yet exist. But plenty of startups, researchers and billionaires are trying to make the dream a reality – for those with large bank accounts, at least.

Prosper Robotics, founded by former OpenAI staffer Shariq Hashme, has built Alfie to do chores while you're out. Tesla is working on the humanoid Optimus to help around the house (and in Tesla factories). And humanoid robots are in the works for a variety of use cases, including warehouses and retail, from companies such as California's Figure, Norway's 1X Technologies, Oregon's Agility Robots and Canada's Sanctuary AI.

Nor should we forget that Honda, Toyota and Sony have long been working on humanoid robots for home and industrial use. Still, robobutlers continue to remain just around the corner, just as they have for as many years as we can remember.

Early movers

You can make the argument that home robots already exist. Roombas have been vacuuming homes for over two decades, with 20 million sold during that time, and there are now bots to wash your windows, mop your floors, scrub your BBQ grill and even clean your pool. But there's a big gap between making specialist devices such as these and a general robot to operate in a home.

Even Amazon has struggled. In 2018, the tech giant was rumoured to be working on a domestic robot under the codename Vesta, only to send up a metaphorical white flag four years later when it acquired Roomba maker iRobot for $1.7 billion (a deal currently being examined by regulators).

And consider Boston Dynamics, perhaps the world's best-known robotics maker. While it's famous for the bipedal robot Atlas, that was only built because the US military threw a big contract at the company. So far, the firm has commercialised just one robot: the four-legged Spot, which is used for maintenance and monitoring in dangerous situations such as oil rigs, nuclear plants and bomb scares.

"If you have a particular application I think you should design something for your application," Marc Raibert, co-founder of Boston Dynamics and now the head of its AI Institute, told me at the IEEE's International Conference on Robotics and Automation (ICRA). "If you have a set of applications, you need to do a balance between generality and a solution. I think it's going to be tough to get humanoids to do lots of practical work."

He added: "There'll be some things they're the right thing for – you know, some people argue that spaces are designed for humanoids and therefore a human form works. But Spot does pretty well [in those spaces], so there's a lot of things that could go in this place."

Boston Dynamics' next robot is a big box on wheels with an arm that can grab cardboard boxes from pallets using suckers. Stretch is already being tested at warehousing and shipping companies. In his keynote at ICRA, Raibert explained that Stretch is actually a derivative of Atlas, but as it was developed it evolved away from two legs to wheels to a clunky base, becoming less humanoid. Stretch is designed to replace human workers in a

hard job, but it doesn't need to look like us to be successful.

Movement and thinking

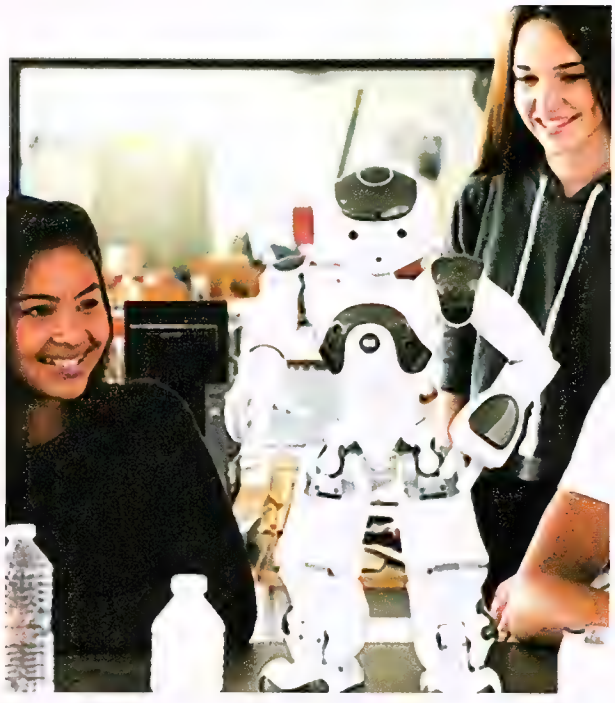
Why is making a human-shaped robot so difficult? First, there's the machine side. Building a robot that can walk around a home safely is no easy task. If a bipedal robot's power or controls cut out, how do you ensure it doesn't fall and crush the family dog? Then you'll need a super manoeuvrable arm with a gripper that can clasp objects as delicate as mugs and plates. This all exists now, but at high cost.

The other problem is intelligence and automation. There's something you need to know about the whizzy robot videos on YouTube: they're as choreographed as Swan Lake. Consider two recent Boston Dynamics videos. The first (**tinyurl.com/APC524dance**) features the bipedal Atlas and four-legged Spot dancing to the Motown classic "Do you love me" – the performance is so remarkable that comments under the video wonder if it's CGI. The bots have rhythm, they have actual moves.

But it took months of programming to make the video. The robots haven't learned to dance – this is the only routine they can do. Adding further to their repertoire requires more programming. That matters when it comes to robot butlers. It's possible to program an Atlas or even a Spot to clear your table and load your dishwasher, but it would need to be reprogrammed – or at least adjusted – for every home. There is as yet no AI that can manage the task, and we all have different homes. That's just for one chore.

"You know the phrase, if it walks like a duck, if it sounds like a duck, then it is a duck?" said Raibert. "Well, with robots it's not that way. That looks like a person and moves like a person for some things. It's got the shape of a person. But that doesn't mean it's got the intelligence, or the morality or immorality, of a person. It doesn't really mean anything."

Robotics companies choose a problem to work on, but that doesn't mean they're solving every challenge. Boston Dynamics has made robots that move around well, but that doesn't mean they have true intelligence. People see promo videos and make assumptions. As Raibert put it: "We're experts at making them look good."



Above left: Tesla's Optimus is designed to help around the house – and in its factories.
Above: The Nao is one of the most successful humanoid robots.

There's another Boston Dynamics video that's worth watching (**tinyurl.com/APC524jump**). It shows a bipedal Atlas leaping around scaffolding, tossing a bag up to a human worker, and doing a backflip off a platform to get back to the ground. Again, it's remarkable – and again, it's heavily programmed. To be clear, it does have automation and intelligence: it can analyse data from sensors to maintain balance, sees with computer vision, and has a system that lets Atlas decide on a rough path once it's been told where to go and walk, jump or backflip its way into position.

Those built-in facets of intelligence are continually being improved, adding to Atlas' skills one by one. Raibert notes that careful watchers of Boston Dynamics videos might have noticed that Atlas tends to backflip from up high and land at a lower level. There's a reason for that: the company needed the extra time to get Atlas to rotate fully before landing. After careful programming adjustments, Atlas can now backflip from ground level. "It's gotten more flight time, more rotation rate, without any changes to the hardware," Raibert said in his keynote at ICRA 2023.

Below: Stretch shows that robots don't need to look like us to be successful.

Step by step, robots are getting better at navigating our world without as much hand-holding from us. But controlling robots is such an intractable problem that the robot butler developed by Prosper Robotics isn't controlled by AI or even programmed – it's driven remotely by employees in the Philippines wearing VR headsets. That idea is also behind Toyota's T-HR3 and Honda's Asimo follow-up, the Avatar Robot, both of which use human operators, as does 1X's EVE, letting a remote operator step in when needed. Such robots still have intelligence, in that they "know" how to walk, can navigate a space and perform basic tasks, but the remote operator makes the decisions and directs the actions.

Why not just hire a maid or a cleaner? There are benefits to a human-controlled robot: they can do small tasks and then return later in the day for a few minutes when needed, while a human cleaner comes for one set tranche of time; it removes the middle-class awkwardness many people feel when paying someone else to scrub their toilets; and it lets us outsource cleaning overseas where the

minimum wage is lower. That list may not make anyone's marketing brochure, but such human-driven avatars could help find labour in difficult-to-fill jobs – such as care work – or more dangerous, unhealthy-to-human roles.

Dreaming of humanoid bots

There are humanoid robots you can buy now. Or Nao, we should say. Released in 2006 by French robotics company Aldebaran – before it was bought by Japan's Softbank and subsequently sold to Germany's United Robotics Group – the Nao is one of the world's most successful humanoid robots. With built-in obstacle detection, Nao can walk, get up if it falls and even play football, as it's used to make up the teams of one part of the RoboCupSoccer challenge.

As well as speaking 20 languages using four microphones, the Nao also has seven sensors to feel its way through the world, and a quartet of cameras. With a sixth edition launched in 2018, more than 13,000 are in use around the world, largely in schools as a programmable teaching assistant or a research platform.

So why isn't Nao the answer to our bipedal humanoid robobutler dreams? First, because it's just a little guy, at 58cm tall. It couldn't reach your table to grab your dirty dishes. Second, it lacks the built-in automation and AI to figure out how to load the dishwasher.

You could certainly program Nao for your own household tasks, but you'd have to be pretty good at robotics software engineering. That football challenge is part of a wider RoboCup, one aspect of which is teaching robots how to do household chores – programming a robot butler to do basic tasks is so hard it's part of a global challenge.

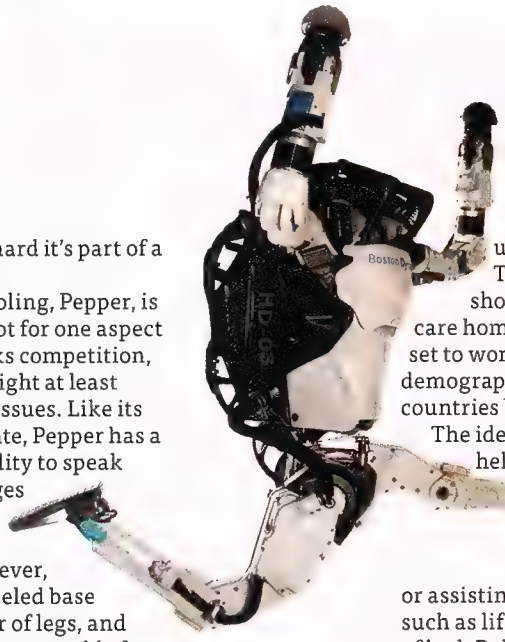
Nao's bigger sibling, Pepper, is the platform robot for one aspect of that home tasks competition, and at human height at least solves the reach issues. Like its smaller stablemate, Pepper has a cute face, the ability to speak multiple languages and can move around of its own accord; however, Pepper has a wheeled base rather than a pair of legs, and features a touchscreen table for additional human interaction. Pepper has been used for everything from cheerleader to receptionist, but has struggled with more complicated roles, reportedly failing to hold jobs leading funerals and aerobics classes.

Caring roles

Robots might never make it into most homes for more practical reasons. Rolling robots can't navigate stairs, these machines are incredibly expensive and they're inherently large – where do they stand when not in use? Curl up in the closet? Lurk in a corner in the spare bedroom? Chill in the garage next to your car?

And what happens if they mess up? There are plenty of social media stories about robot vacuums failing to spot faeces left on the carpet by the family dog and diligently smearing it evenly across the entire living room. That bug has since been addressed, but the more we automate the more frequent we'll find unexpected mistakes – and robot butlers would be so much bigger than a Roomba, so the potential for damage is considerable.

Still, there's one type of home that robotics makers and their investors have long been eyeing up: the care home. There's already a shortage of workers for care homes and in-home carers, set to worsen as the demographics of Western countries become older.



Above: Boston Dynamics' Atlas was built thanks to funding from the US military.

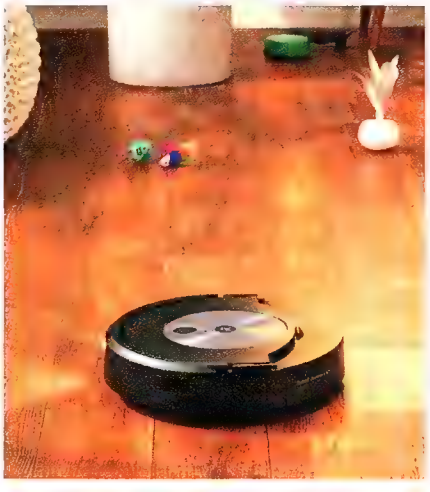
The idea is that robotics could help support staff in care homes, either taking on repetitive tasks or assisting with heavy loads, such as lifting people in and out of bed. Robots could also help people stay in their own homes, be it helping the elderly move around, doing basic household tasks, and even administering medicine or monitoring indicators such as blood pressure.

This use case makes more sense. Robots are expensive, but so too is social and health care. We lack employees. People may prefer having a robot in their home than a person, feeling it less invasive for trips to the loo or getting dressed – though of course some people may prefer a human.

David Hanson, CEO of Hanson Robotics, said in a panel at ICRA 2023 that his company's lifelike Sofia and Alice robots have been successfully deployed in elderly care as well as acting as therapists and supporting people with autism. In one study, the robots were more effective than human therapists, he said, because people didn't feel judged by the robot. "They weren't self-conscious with the robot," he said. "The robots can be more useful in some regards, and also helped to extend the capabilities of our overburdened healthcare staff."

It's hard to see leaving our elderly to be managed by robots as anything other than a lonely dystopia, but if deployed sensitively and alongside human help, they could be useful tools. Avatar-style robots could fill both roles at once, offering a human – remote though they may be – to check in and chat with a housebound person, while also taking out the bins and making a quick meal.

That could be the foot-in-the-door for robots in the home, but for most of us, the closest we'll get to a robobutler is a Roomba. Which is a shame, as I could really do with someone making me a cup of tea after writing all this. ■



Below left: Robots such as Pepper could help out in care homes.
Below: Robot vacuums have been known to spread the dirt rather than clean it.

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$1,649, microsoft.com

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$4,059, dell.com/en-au

ALTERNATIVES

LENOVO THINKPAD T14 GEN 3 (INTEL)

An awesome keyboard, slim design, customisable spec and fine selection of ports make this a great business laptop.

$1,909, lenovo.com/au

ACER TRAVELMATE P6

Not the most powerful due its 11th gen Core chip, but a great 14in screen and keyboard, superb battery life and competitive price lift it above rivals.

$2,179, acer.com

DYNABOOK PORTEGE X40L-K-101

A simply brilliant 1kg 14in laptop that excels in all areas, including superb battery life. This model features a solid i7 CPU with a 512GB SSD.

$2,428, anz.dynabook.com

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A SUPERBLY ENGINEERED GAMING POWERHOUSE

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~$3,199, razer.com/au-en

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RAZER BLADE 18

A great advert for 18in gaming laptops, the Blade 18 partners a Core i9-13950HX with RTX 40-series graphics in a stunning, slim design.

$4,499, razer.com/au-en

ASUS ROG STRIX SCAR 18

It's expensive, but if you want an 18in laptop that delivers all-out power this is the no-compromise 3.1kg beast to buy – it packs quality everywhere.

$4,999, asus.com/au

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$1,945, au.store.asus.com

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APPLE MACBOOK AIR 15

An awesome plus-size MacBook Air with great battery life and graphical performance. GPU performance and battery life are the standout perks here.

From $2,199, apple.com/au

HP PAVILION 14

This slim 1.4kg laptop is a superb choice for anyone on a tighter budget. it struck an excellent balance between speed and battery life – around ten hours.

From $999, store.hp.com

CHROMEBOOKS

ASUS CHROMEBOOK FLIP CX5

The best big-screen Chromebook we've tried, with a bright 15.6in Full HD display with decent black levels and surprisingly rich colours. And it's a good specification for the price, with a Core i5 processor, 8GB of RAM and a 256GB SSD in tow.

$797, asus.com/au

LENOVO FLEX 3 CHROMEBOOK

This isn't the most powerful Chromebook, but students need reliability more than power – especially if they're only really using it for homework, note-taking, and perhaps the occasional bit of Netflix.

$484, lenovo.com/au

LENOVO IDEAPAD DUET

The Chromebook answer to Microsoft's Surface tablets, this is a seriously versatile device – albeit not the speediest (although we never found it to be painfully slow while carrying out everyday tasks). For this price, and with a 16hrs 14mins battery life, the Duet is a great choice.

$599, lenovo.com/au

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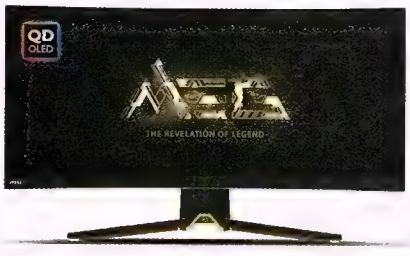

EIZO FLEXSCAN EV2480

Businesses in particular will love this easy-to-roll-out 24-inch monitor, with its exceptional five-year warranty, USB-C port for easy docking, excellent viewing angles and delicious whites. And it has the best OSD around.

$699, eizoglobal.com

DELL S2721DS

The Dell S2721DS is a solid and affordable QHD monitor that'll suit general users and casual gamers alike. It boasts a gorgeous 27-inch 1440p display, a 75Hz refresh rate, and a vivid IPS panel that hits 99 percent of the sRGB color gamut.

$341, dell.com.au

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CREATIVE MASTERCLASS

As the price indicates, this monitor is for heavyweight creatives who demand the best in every discipline: HDR video editing, print layouts, professional photography and more besides. With superb coverage and accuracy across all spaces, plus a built-in calibrator, it justifies the investment.

$5,995, eizoglobal.com

BENQ PD2725U

By no means a cheap 4K 27-inch monitor – unless you compare it to the Eizos – but it marries all-round quality with ease of use thanks to a puck that allows you to quickly move between settings. You can even daisy chain a second Thunderbolt 3 monitor for a monster setup.

$1,599, benq.com

ASUS PROART PA279CRV

Asus's new 4K productivity panel delivers near pro-levels of performance and precision, though its HDR capability is inevitably limited. What you get is Asus's usual high levels of build quality, plus extras, including essential HDR support and a stand that includes rotation into portrait mode.

$849, asus.com

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EPSON ECOTANK ET-1810

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There's nothing flashy about this bottle- fed inkjet: it's there to churn out pages at a decent rate (8.8ppm for black text) for a low price. It comes with enough ink for 4,500 black pages and 7,500 in colour, but refills are cheap. Just don't expect features like duplex printing.

$265, epson.com.au

CANON PIXMA PRO-200

Yes, it's big and it's expensive – and you don't even get a scanner – but the Pixma Pro-200 means that you can print A3 photos with glorious colour accuracy and detail. If you're after an office workhorse, look elsewhere, but it can't be beaten on photo quality.

$809, canon.com

BROTHER MFC-J4540DW

Home workers will love this inkjet all-in-one. It combines an incredible range of features with all the connectivity you need and extreme ease of use. Output quality is fine, it offers the best cloud support around and the high-capacity ink pack could keep you going for years.

$329, brother.com

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$359, synology.com/au

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The most splendid, overpowered router on the market. But, it's silly money and aspirational to most users. Ultimately, though, it's currently the highest-spec consumer router available.
$999, asus.com/au

ASUS TUF GAMING TUF-AX4200
Ultimately, this is one of the very best featured and fastest routers we've ever tested and, at $320, it's a steal. It's affordable, fast and dripping with features. Only power users might want more performance headroom.
$269, asus.com/au

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TP-LINK DECO XE75 AXE5400
SUPERB WI-FI 6 MESH
Offers the simplicity, speed and range most people want from a mesh system. While it's expensive, nothing else offers the plug-and-play simplicity, speed and range afforded by the Deco XE75.
$699 (2-pack), tp-ink.com

TP-LINK DECO X20
The Deco X20 makes it possible to upgrade your home network to Wi-Fi 6 for the price of some standalone routers. The HomeCare functions are also a great bonus for households where lots of devices are fighting over the bandwidth. **$199 (2-pack), tp-link.com**

ASUS ZENWIFI AX
The interface and design certainly aren't the prettiest (the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect.
$406 (2-pack), asus.com/au

NAS SERVERS

QNAP TS-130
SIMPLE HOME NAS
An above average CPU and RAM combo, solid features and affordable price make the QNAP TS-130 worth considering. Alternatively there's the two bay TS230 which features the same CPU, with 2GB of RAM, dual drive bays, and an extra USB port on the front for a modest ~$50 price increase.
$199, qnap.com

ASUSTOR NIMBUSTOR AS5304T
This is a hugely powerful four-bay NAS that will be overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor AS5304T for both its speed and flexibility.
$799, asustor.com

SYNOLOGY DISKSTATION DS1522+
At $1,199 it's not cheap but factoring in the software means it's great value. Though some internal silicon may lack headroom, this is still a well-featured, expandable NAS with fantastic software. The best part is the DSM software.
$1,199, synology.com

SECURITY SOFTWARE

G DATA TOTAL SECURITY
A suite for power users with a host of useful features that offers formidable protection against viruses.
US$49.95, 1 device, gdatasoftware.com

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AVAST ONE ESSENTIAL
The only product in our tests to score a 100% protection rating for blocking all malicious files, this reliable choice is our pick of the free AV tools and includes a free if limited VPN service. **Free, avast.com**

MCAFEE+ ADVANCED
A high-end choice with high-end features and support for an unlimited number of devices. Good value for the first year, but watch out for renewals.
$139.95, individual, unlimited devices, mcafee.com/en-au

VPNs

NORDVPN
NordVPN provides consistent and fast speeds, serious security, great support for video-streaming services and some cost-effective subscription rates.
$59 per year, nordvpn.com

ALTERNATIVES

PROTONVPN
ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options.
Free, protonvpn.com

SURFSHARK
A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services.
$79.61 for one year, surfshark.com

PASSWORD MANAGERS

BITWARDEN
Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge. **Free, bitwarden.com**

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DASHLANE
A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan ($60 per year) as this extends the service to six people.
$55.99 per year (Premium), dashlane.com

1PASSWORD
1Password is targeted at technically minded users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials.
$54.99 per year (individual), 1password.com

The best wireless headsets for gaming

Excellent audio without the anchor of a cable tying you to your desktop. That's the starting point for a good wireless headset for gaming. Next up, there's battery life. Some will last a few days on a single charge. 30 hours of battery life is a decent starting point, but others will go hundreds of hours. Yes, really. Then there's the whole Bluetooth versus Wi-Fi thing. Bluetooth is often used only as a battery-saving option because, as a gamer, you want that essentially lag-free 2.4GHz Wi-Fi connection instead.

1

HYPERX CLOUD ALPHA WIRELESS

$277, www.hyperx.com

The Cloud Alpha is a wireless wonder for PC gaming. It has superb sound, a clear mic, and DTS surround. Music sounds amazing and the directional sound when playing games is if anything even better. You can actually navigate around games using noises with these impressive cans. They're also light and comfy, with a whopping 300-hour battery life. It's without any doubt the best wireless headset we've tested so far.

2

RAZER BLACKSHARK V2 PRO

$169, www.razer.com

Comfy, reliable, and with a good battery life, the V2 Pro is a fantastic refresh of an old favourite. The TriForce driver design apes the fantastic HyperX Cloud Alpha headset and matches its fantastic audio delivery. They're also super comfortable, and having a physical volume dial is useful. Our only issue is that the boom mic is a little weak, but now the price has fallen to $170, we can definitely live with that.

3

AUDEZE MAXWELL

$469, www.audeze.com

Audiophiles will be pleased with the Audeze Maxwell's planar magnetic drivers. They're expensive, but deliver gorgeous, natural sound, even if their larger magnets make for a heavy headset at 490g. Add fast charging, great battery life, and a good mic, and there's little to dislike. You also get four connectivity options, including a 3.5mm jack, USB type-C, Bluetooth 5.3, or 2.4GHz Wifi.

4

CORSAIR HS80 RGB

$189, www.corsair.com

With a great floating headband design, the Corsair HS80 RGB is a super comfy wireless headset. It boasts the latest lag-free Slipstream Wireless tech for ultra-low-latency in-game audio. Pair that with excellent Hi-Res Audio and Dolby Atmos, plus a fantastic microphone, and you're onto a winner. Note that the feel is a little bulky and the connectivity is limited. You get neither a 3.5mm analogue jack nor Bluetooth support. If you're okay with that, then the rest of the package is great.

5

JBL QUANTUM TWS

$98, www.jbl.com

Not too bad price-wise, the JBL Quantum TWS earbuds come with dual-connection, great noise cancelling, and easy touch controls. Thanks to ultra-low latency, they're fantastic for gaming and less bulky than a headset. They're not the best-sounding buds we've tested, but there's enough bass to blow out your eardrums. The noise cancelling is decent, too, even if it inevitably cuts down the battery life from an already unspectacular eight to a borderline problematic five hours. ■

HEAD TO HEAD

Start 11 vs StartAllBack

Change how the Start menu looks with these apps.

■ **Stardock Start 11** $10.99 (single license) ■ **StartAllBack** US$4.99 (single license)

The Windows 11 Taskbar and Start menu have been, shall we say, a little divisive. There hasn't been a storm of complaint like this since the last time Microsoft tried to shake up the way we interact with our computer's operating system, and while Windows 11 doesn't make changes to the extent Windows 8 did, its pared-back menu has led those more used to the way Windows 7 and 10 worked to feel that something is missing.

Enter the third-party software. Stardock had a popular app that 'fixed' Windows 8's Start menu, called Start8, and it lives on today in the form of Start11. StartAllBack does a similar thing, but rather than confining itself to the Start menu, it also makes changes to the Taskbar, Explorer, Control Panel, contextual menus, and UI colour.

Both apps can be tried for free, so you can test them out and decide which approach to customising the Windows 11 Start menu you prefer before making a financial commitment.

There are actually a few things you can do in Windows to undo some of the most egregious interface changes, the easiest of which is to move the Start button back to the left-hand corner. To do this, right-click the Windows 11 Taskbar and choose Taskbar Settings, then drop down the Taskbar Behaviors section of the settings pane that appears. From here, choose Left instead of Center as your Taskbar Alignment. From the Personalisation > Taskbar pane, you can also remove chat and the search box from the Taskbar if you want to, as well as control how apps get your attention with badges or by flashing.

Alternatively, you could use it the way Microsoft intended, taking the time to get used to the new way of doing things and accept that the good people from Redmond, Washington know how to design a PC UI. We thought not! Let's get customising!

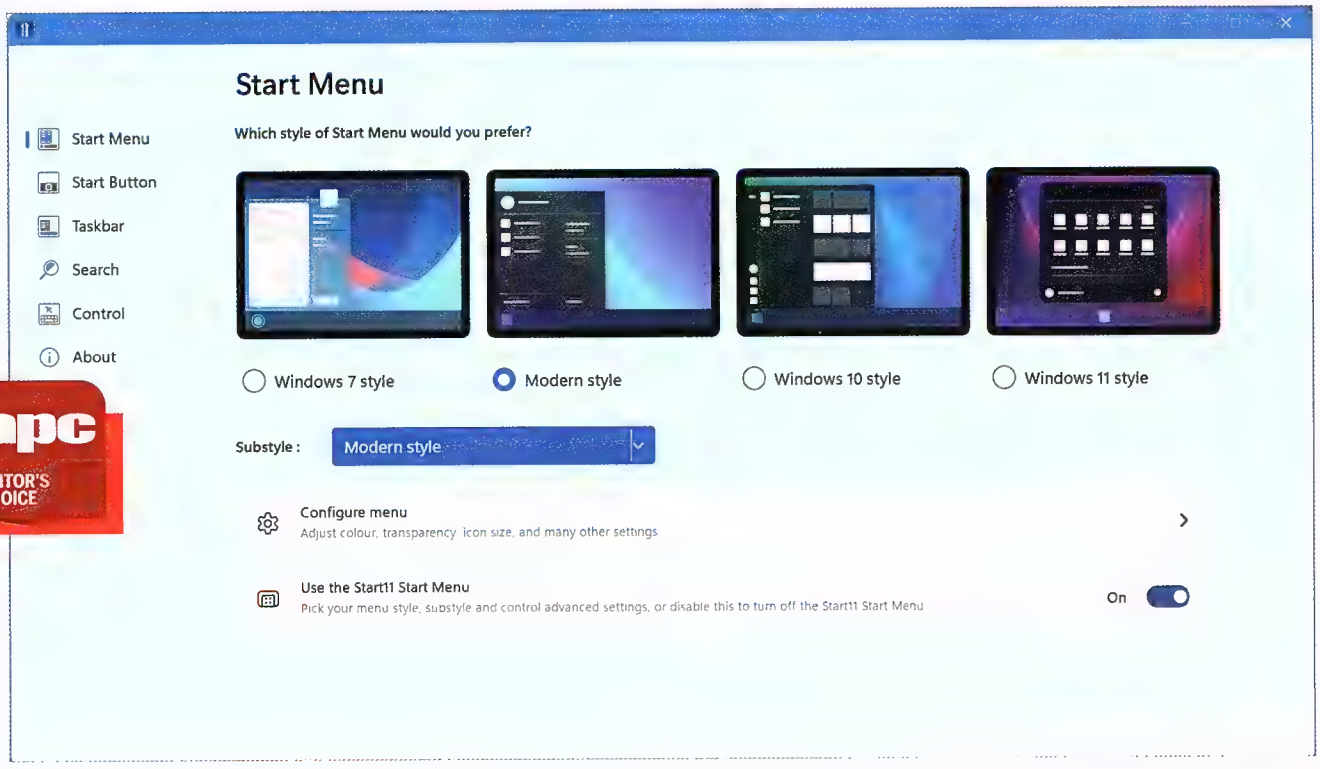
Start11

Stardock's app has a couple options for customising your Start menu. There's a menu that looks a lot like that from Windows 7, one that looks like Windows 10's, and a 'Modern' menu of Stardock's own devising. It's this Modern menu that has become our favorite in testing, as while aping Microsoft's past glories is nice, it's good to see a bit of thought put into taking the Start menu forward in a different direction.

Start11 can be purchased for a single PC as a license that covers five devices, or as part of Stardock's Object Desktop subscription, which nets you a whole customisation package of apps for an annual fee. You can also get it on Steam. It receives frequent updates, with recent patches adding improved support for multiple monitors, touch devices, and being able to close an individual window from the Taskbar instead of having to close every window an app has open.

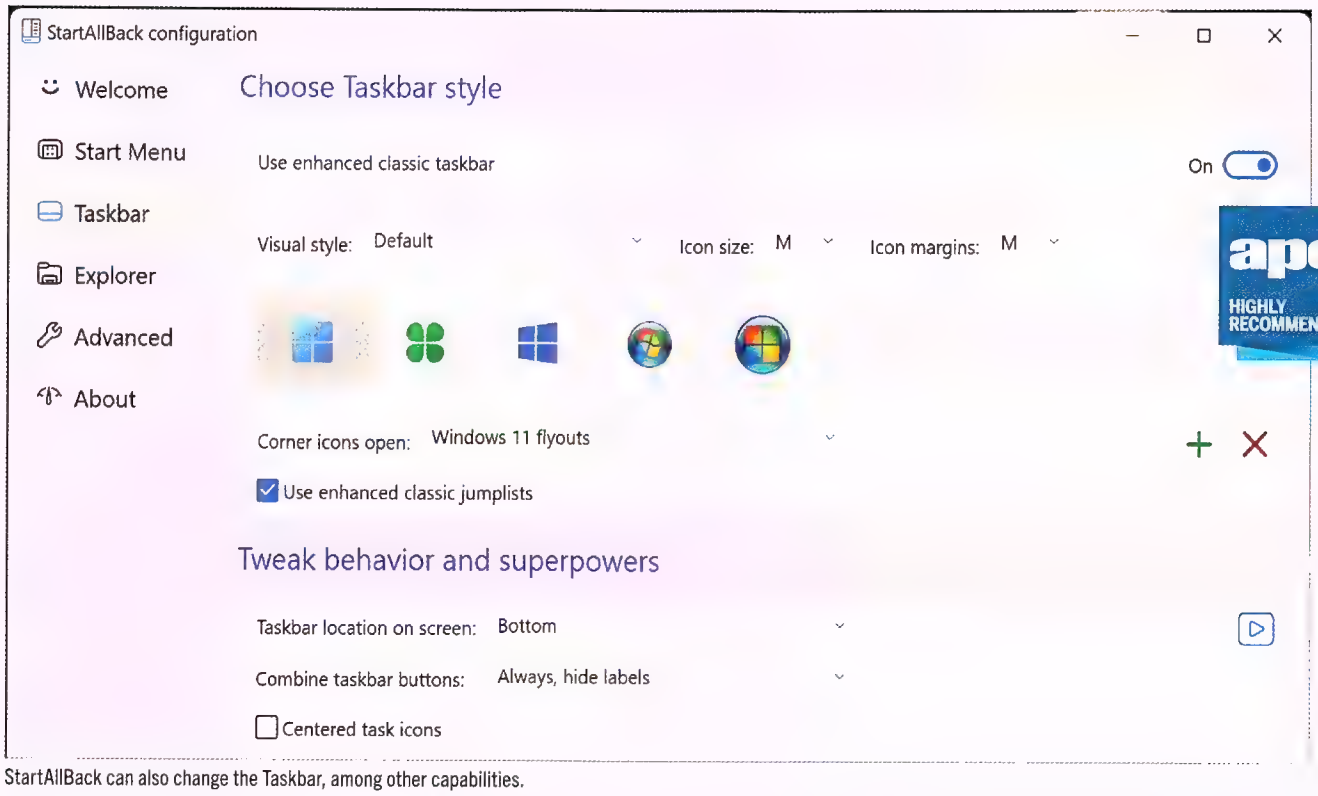
Alongside the replacement Start menus, there's custom Start button support, Taskbar options that affect how apps are grouped and how big they are while minimised, colours and textures, and how it behaves across multiple screens.

There's also an option to use Start 11's search functionality instead of



apc EDITOR'S CHOICE

For us, Stardock's Start 11 just about edges this head-to-head.



StartAllBack can also change the Taskbar, among other capabilities.

Windows', which ties in with Stardock's Fences organisation app from Object Desktop. It adds filters to your search results, allows you to search in open Edge tabs, and can search file contents, too. You can even add Start menu shortcuts to your network drives if you want to.

Once you've installed and configured the software, you can run the app again to change your options, or right-click on the Taskbar to make alterations.

StartAllBack

This app, which is slightly mysterious about its origins (a link on the license key page goes to a Russian-language site), offers more options and granular control than Start11, but achieves broadly the same aims. It's available as a single, double, or triple license, depending on how many PCs you want to install it on. There's no subscription option, so you only pay once.

There are three main 'themes' available, called Proper 11, Kinda 10, and Remastered 7, all of which overhaul the appearance of your Windows 11 desktop in various ways, including the Start button, its menu, and the colour of the Taskbar. If you're not satisfied with these, you can delve into their settings.

The Start menus are all of the two-column variety, straight out of Windows 7, with applications on the left and documents on the right. Changes you make in the app are reflected immediately in the Windows UI, with no clicking of OK or Apply needed. You can delve into some serious detail with the items on the menu and their behavior, too, choosing which folders to display on the right-hand side,

From StartAllBack, it's also possible to change the Windows logo on the Start button, with an angled Windows 10-alike, plus some 7 or Vista-style 3D rounded effects, available alongside the flat-on Windows 11 logo and even a green, shamrock-like symbol.

There's more to StartAllBack than just Start menus, however. It's also capable of changing the Taskbar, and the interface of Explorer windows. Windows 11's ribbon interface can be as annoying as its Start menu changes, hiding the option you want out of sight behind a drop-down, so the ability to have a Windows 10-like cacophony of places to click, as well as Windows 11 or 7-inspired views, is nice to have.

> "Both apps can be tried for free, so you can test them out and decide which approach to customising the Windows 11 Start menu you prefer before making a financial commitment."

Moving onto the rest of the Taskbar, StartAllBack allows you to split it into sections. Want your Start menu, search box, and widgets in the corner, but application icons in the middle? It's got your back. You can also make the Taskbar transparent – either completely, or just the unpopulated sections.

Unfortunately, in our testing we found that StartAllBack exhibited some unusual behavior. Once we'd installed it, configured it, used it for a bit, then restarted our test PC, it seemed to disappear, the app no longer visible in search. The only way we could get back to the settings screen was to uninstall then reinstall again. This is less than ideal.

One other thing to beware of: don't try installing both these apps at the same time. We did it in an attempt to save time while taking screenshots for this article, and were left with a Start menu that constantly popped up and down of its own accord, each time taking focus away from what we were trying to do. Only restarting the PC then uninstalling the apps could fix it.

This aside, if you want to change the Start menu on your Windows 11 PC, there are two really good options out there. Some may also point to Explorer Patcher, which is free and makes Windows 11 more like Windows 10, but of the two options we've highlighted here, Start 11 takes the crown for reliability, while StartAllBack comes with more options. Make use of the free trials to test them both out, and see whether the changes they can make to your PC UI fit with the way you want to use it. ■

Stardock Start 11 Stable software with nice-looking menus, but has fewer options than StartAllBack.

★★★★½

StartAllBack Lots of options and interface customisations. We experienced some unstable behavior.

Ian Evenden

★★★★☆

TECHNOTES

Gadgets

Delightful devices.

❶ NAD C 3050 STEREOPHONIC AMPLIFIER

$2,299 | nadelectronics.com

When it comes to high-end audio, the NAD Electronics C 3050 is a serious contender. Designed to celebrate 50 years of hi-fi mastery, the NAD C 3050 amp marries 70s retro styling (walnut-finished vinyl-clad cabinet, push buttons and Dual VU meters) with the very latest sound tech. This includes a HybridDigital UcD output stage and a Texas Instruments PCM5242 differential digital-to-analogue converter (DAC), which combine to deliver what NAD describes as "immersive three-dimensionality and thrilling dynamics'. The C 3050 also features NAD's future-proofing Modular Design Construction, with the option to include a module in the rear MDC2 expansion slot that enables BluOS high-res, multi-room streaming and Dirac Live room correction. Cool.

❷ FIIO FT3

$499 | fiio.com

FiiO's latest full-size high-res cans do not disappoint, especially given the price point. The 60mm dynamic driver handles bass, mid-range and treble sounds with confidence; it also helps to eliminate distortion and extends the frequency response. The aluminium alloy headband frame is strong yet light for long-wear comfort. You get a choice of two different earpads for the open-back cups – suede and leather – and the cups can be swivelled through three axes. You also get four audio plugs – XLR, 4.4mm, 3.5mm, and a 6.3mm adaptor.

3 EVE FLARE

$179 | evehome.com

Solar lighting. That's all well and good in the summer. Well, actually it's only occasionally well and good in the summer. And an epic fail in the winter. What you need is an outdoor light that's guaranteed to work – like the Eve Flare. The LED Flare boasts IP65 water resistance but it's actually just as happy indoors as out. It's lightweight and portable and can provide up to six hours of unplugged lighting. You can choose from a spectrum of colours and, thanks to Bluetooth and Thread tech, you can control the light using Apple Home, Siri or the free Eve app.

4 SONY SRS-XV800

$845 | sony.com.au

Sony's powerful wireless 'party' speaker looks and sounds the business. The speaker, which features a built-in handle and wheels, can provide you with ambient lighting and omnidirectional, distortion-free sound, courtesy of the X-balanced speakers. You get up to 25 hours' play time and the speaker is IPX4 splash resistant. And just in case that's not 'party' enough for you, there are microphone and guitar inputs for karaoke fun and more. Don't leave home for that pool party without it.

5 BENQ V5000I

AUD$TBA | benq.com

BenQ describes the V5000i as an 'affordable' short-throw projector. Well, it does come with impressive credentials and a worthwhile extra. Running Google's Android TV OS, this RGB laser projector includes support for streaming services such as Disney+ and Netflix, and can support 4K gaming at 120Hz, while delivering clear and colourful images thanks to its 5,000 ANSI lumens brightness and support for up to 98 percent of the DCI-P3 colour gamut. Throw in a 40W sound system with support for Dolby and DTS and a 100-inch ALR Fresnel ambient light-restricting screen and this US$3,499 bundle is bound to be a big hit with film fans and gamers. Popcorn, sadly, is not included.

LAPTOP

Asus Vivobook Pro 16X OLED

This 2023 update to the value packed creative workstation has some impressive features for the price.

■ $3,399 | asus.com/au

Asus has a huge range of devices, so you'd be forgiven for not having come across the Vivobook Pro 16X OLED range before. For the uninitiated it's a 16-inch creative workstation that prioritises power over an ultra-portable thin and light form factor. Don't get us wrong, the Vivobook weighs a very manageable 1.9kg, but at 2.2cm thick it's half a centimetre thicker than devices like the MacBook Pro 16 and this combines with a lightweight plastic keyboard surround to give it a gaming laptop look.

The powerful components on offer here may be more than capable of smoothly firing up your favourite games after work, but the Vivobook Pro 16X OLED is designed for work – a fact highlighted by the Windows 11 Pro bundling and the Studio Driver pre-installed on the Nvidia GeForce RTX 4060 GPU.

That serious discrete graphics is capable of pushing graphical benchmark performance over 20 percent more than a $10K MacBook Pro 16. The Vivobook Pro 16X OLED has an equally impressive 105W, 24 core Intel Core i9-13980HX CPU that can boost to 5.6GHz and can push between 25 and 90 percent performance bumps over the M2 Max – a pretty serious performance achievement in a similarly sized laptop.

This serious increase in performance is facilitated by a much bigger power draw of 245W on the Vivobook compared to around 35W on the MacBook Pro. This means that while you'll get around 4 hours and 35 minutes of battery using the Vivobook Pro 16X OLED for light work tasks, you won't be able to really push the device with heavy workloads unless you're close to a powerpoint.

Supporting these powerful components is an impressive 16-inch, 120Hz, OLED display that very much takes on the Gigabyte Aero 14 (opposite page) for offering the best OLED screen on a laptop. This larger 3200 x 2000 pixel display also has a peak 600nit brightness, Vesa DisplayHDR True Black 600, 100 percent DCI-P3 colour validated by Pantone and an ultra-fast 0.2ms response rate. It's undeniably another contender for the most impressive laptop screens to work on.

If performance and the screen specs aren't enough to convince you that this laptop is an impressive and unique offer, Asus offers the DialPad functionality on the Vivobook Pro 16X OLED's trackpad, allowing you to quickly change a wide array of settings in creative applications. It's also got a fingerprint sensor, number pad, physical webcam shield, and a wide array of interface options including; Ethernet, HDMI and an SD card slot, to name a few.

The Harmon Kardon designed speakers are Dolby Atmos compatible and compliment the impressive screen, and Asus has harnessed the new AI capabilities of this 13th gen Intel chip to offer onboard AI background noise cancellation for web meeting audio, and can blur backgrounds and change focus settings for video.

It's a different beast to the on-the-go work offering of the MacBook Pro 16, but when you get the amazingly powerful Vivobook Pro 16X OLED with 32GB of RAM and a 1TB SSD slot for $3,399 it's a pretty compelling alternative.

■ W11 Pro; 16-inch OLED at 3200 x 2000 pixel resolution, 120Hz, 0.2ms response rate, 600 nit Peak brightness, 100% DCI-P3; Intel Core i9-13980HX CPU; 32GB RAM; Nvidia GeForce RTX 4060 (140W); 1TB PCIe SSD; 93Wh battery (4h13min 1080p movie playback); 35.5 x 24.9 x 2.2cm; 1.9kg.

	Asus Vivobook Pro 16X OLED	MacBook Pro 16 M2 Max
Geekbench 5 - Single-core (score)	2,115	2,043
Geekbench 5 - Multi-core (score)	18,934	15,129
Cinebench R23 - CPU (multi-threaded)	28,443	14,661
Geekbench 5 - OpenCL (score)	100,503	77,966
Sid Meier's: Civilization VI - 1080p Ultra (FPS)	119	63
Battery life - 1080p video playback (h:min)	4h13min	20h20min
BlackMagic Disk Read(MB/s)	3,952	7,741
BlackMagic Disk Write (MB/s)	2,957	5,727

A surprisingly powerful creative workstation that's good value for those ok with less battery.

Joel Burgess

★★★★★

LAPTOP

Gigabyte Aero 14 OLED

This sleek creative workstation has the brightest OLED screen you can get on a laptop.

■ $2,999 | gigabyte.com

■ W11 Home; 14-inch OLED display @ 2880 x 1800 pixel resolution, 90Hz, 100% DCI-P3, Display HDR 600 True Black; Intel Core i7-13700H CPU; Nvidia GeForce RTX 4050 (45W); 16GB RAM; 1TB PCIe SSD; 63W battery (4h 45min 1080p movie playback); 31.1 x 22 x 1.7cm; 1.49kg.

It's been a while since we last covered an Aero from Gigabyte, and it seems the range that was once defined by its pops of orange and green on the cover has matured into a sleek silver workhorse that won't rock the boat in an office setting. It's nice to see that the company is still forging its own path in laptop design with unique little details like an HDMI port at the rear of the device that looks like the exhaust of a sportscar and fast looking set of thermal vents. But while the design of this device is nice, it's hardly the reason you'll be looking to drop the $3k asking price on it. But don't be worried, there's plenty of reasons that the 2023 Aero 14 OLED more than justifies its price tag.

The most striking feature of this device is undoubtedly the screen. Not only is it OLED, which is still impressive even though it's reasonably common these days, but that OLED panel offers a 2880 by 1800 pixel resolution and Vesa DisplayHDR 600 True Black certification. The 600nit peak HDR brightness threshold required for that certification means that this deep black OLED is also capable of higher brightness levels than any other laptop we've tested, baring only the current Apple MacBook Pro range (which are much higher, but not OLED). This combines with the high 90Hz refresh rate and full DCI-P3 colour gamut to make a screen that is perfect for content creators and professionals needing that extra colour range, clarity and smoothness for working long sessions.

This screen is supported by some great components thanks to a powerful 45W i7-13700H CPU from Intel which is close to 20 percent behind what you'll get from one of the M2 processors on an MacBook Pro running an M2 Pro or Max, but this chip is still capable of handling demanding workloads on the go. The Aero 14 OLED also comes with a Nvidia GeForce RTX 4050 (45W TDP) GPU which will offer comparable performance to even the most highly specced MacBook Pro 14 devices. The GPU comes configured with studio drivers, which makes sense for this pro focused device, but it's more than capable of running modern games at over 60 frames per second using FullHD Ultra settings. This will translate into handling demanding professional graphics work for those that might need it.

This is probably one of the closest PC equivalents we've seen to the MacBook Pro 14 in 2023, which makes a pretty compelling argument for why you might want one. It's even 220g lighter. And while it's thicker, that's only by 1.5mm. The Gigabyte Aero 14 can be picked up with 16GB of RAM and a 1TB PCIe SSD for $2,999, while the MBP 14 starts at $3,199 with a smaller 512GB SSD. There is however one major caveat to the Aero 14 OLED (2023): battery life. Sure three hours and 38 minutes of work time and four hours and 45 minutes of movie playback is in the ballpark for a gaming laptop with discrete graphics, but against the 14+ hours offered by Apple's offering it is a very different product.

"Perfect for content creators and professionals needing that extra colour range, clarity and smoothness for working long sessions"

	Gigabyte Aero 14 OLED (2023)	MacBook Pro 16 M2 Max
Geekbench 5 - Single-core (score)	1,669	2,043
Geekbench 5 - Multi-core (score)	12,375	15,129
Cinebench R23 - CPU (multi-threaded)	12,239	14,661
Geekbench 5 - OpenCL (score)	76,196	77,966
Sid Meier's: Civilization VI - 1080p Ultra (FPS)	98	63
Battery life - 1080p video playback (h:min)	4h45	20h20min
BlackMagic Disk Read/Write (MB/s)	6,965	7,741
BlackMagic Disk Read/Write (MB/s)	5,005	5,727

An great laptop with a top screen for creative professionals that don't care much for battery life.

Joel Burgess

★★★½☆

GAMING PC

Mwave Arctic Flow

Mwave's Arctic Flow Gaming PC combines the best bits from Intel, Nvidia and Gigabyte in a pre-built package at a fair price, so where's the catch?

■ $2,799 | mwave.com.au

If you like the flexibility of a self-built PC, but you're not confident (or just can't be bothered) to piece one together yourself, then it's really not a bad option to look at a third party prebuilt system. Take the Arctic Flow Gaming PC from Mwave, for example, its components have a market value of around $2,785, but it was on sale at the time of writing for just $2,799.

That means you get the benefit of a professional assembling all components for you, configuring BIOS and installing OS software, troubleshooting issues, testing that everything runs well and then offering you a two year warranty for the sum total of $14. Sure, the full retail price is $100 more than that and there's a good chance Mwave is able to make a profit by bulk selling specific components, but as far as the end consumer is concerned it's hard to see a downside here.

The Intel Core i5-3600K included in this rig is PC Gamer's 2023 'Best CPU for most gamers', a highly coveted title that means you're unlikely to need more unless you're really going for a top shelf configuration. Paired with 32GB of RAM and an overclocked Gigabyte GeForce RTX 4070 GPU and this is a seriously competent gaming rig.

This overclocked Gigabyte 4070 was capable of pushing framerates over 60fps using QHD+ Ultra settings and could get even higher 130fps averages using FullHD Ultra settings. This is great performance for the price, since higher specced cards start to offer diminishing returns for their additional cost.

You'd be looking to pair this with a nice QHD display or a FullHD monitor with an ultra-fast refresh rate so you'll probably want to add $400 to $1,500 for the cost of a monitor to your total tally and maybe another few hundred for a keyboard and mouse if you're starting from scratch.

The Nzxt H5 FLow RGB Tempered Glass Mid-Tower ATX Case that houses everything offers plenty of room for the large cooling apparatus on the Gigabyte GeForce RTX 4070 Aero OC 12GB GPU. It's also the perfect size for the Gigabyte Z690 UD AX V2 DDR4 motherboard with space to add an additional M.2 SSD and even room for another graphics card if you decide to upgrade one day since you can't run two 4070s in SLI.

The Gigabyte mobo includes an Intel Wi-Fi 6E chip so you'll get decent Wi-Fi out of the box and the Nzxt case offers a nice array of fans that look awesome thanks to the RGB lights, and the unique base fan design pushes large volumes of air straight onto the GPU with the Cooler Master CPU radiator attaching to the top of the case to extract heat quickly out a different avenue.

The power supply is neatly contained in a separate compartment and a neat cable management system keeps the majority of your cables tucked away. So it's hard to imagine a better build in the mid-range price bracket.

■ W11 Home; Gigabyte Z690 UD AX V2 DDR4 motherboard; Intel Core i5-13600K CPU; Gigabyte GeForce RTX 4070 AERO OC 12GB GPU; 32GB DDR4 RAM; 1TB Samsung 970 EVO SSD; NZXT H5 Flow Mid-Tower ATX Case; Cooler Master ML240L ARGB V2 CPU cooler; Thermaltake Toughpower RGB 80+ Gold 850W Modular Power Supply; 46.4 x 44.6 x 22.7cm; 16kg.

	Mwave Arctic Flow Gaming PC	Intel NUC 13 Extreme Raptor Canyon (i9, 3080 Ti)
PCMark 10 - Overall (score)	8,761	8,772
Geekbench 5 - Multi-core (score)	13,050	22,708
Max CPU Temp (C)	89	100
Cinebench R23 - multi-threaded CPU	23,267	35,382
3DMark Time Spy (score)	17,854	18,651
Cyberpunk 2077 - QHD+ Rray Tracing Ultra DLSS On(fps avg.)	65.24	60.00
CrystalDiskMark Read (MB/s)	3,567	7,082
CrystalDiskMark Write (MB/s)	3,320	6,109

A nicely balanced mid range gaming machine that is built for you at virtually no extra cost.

Joel Burgess

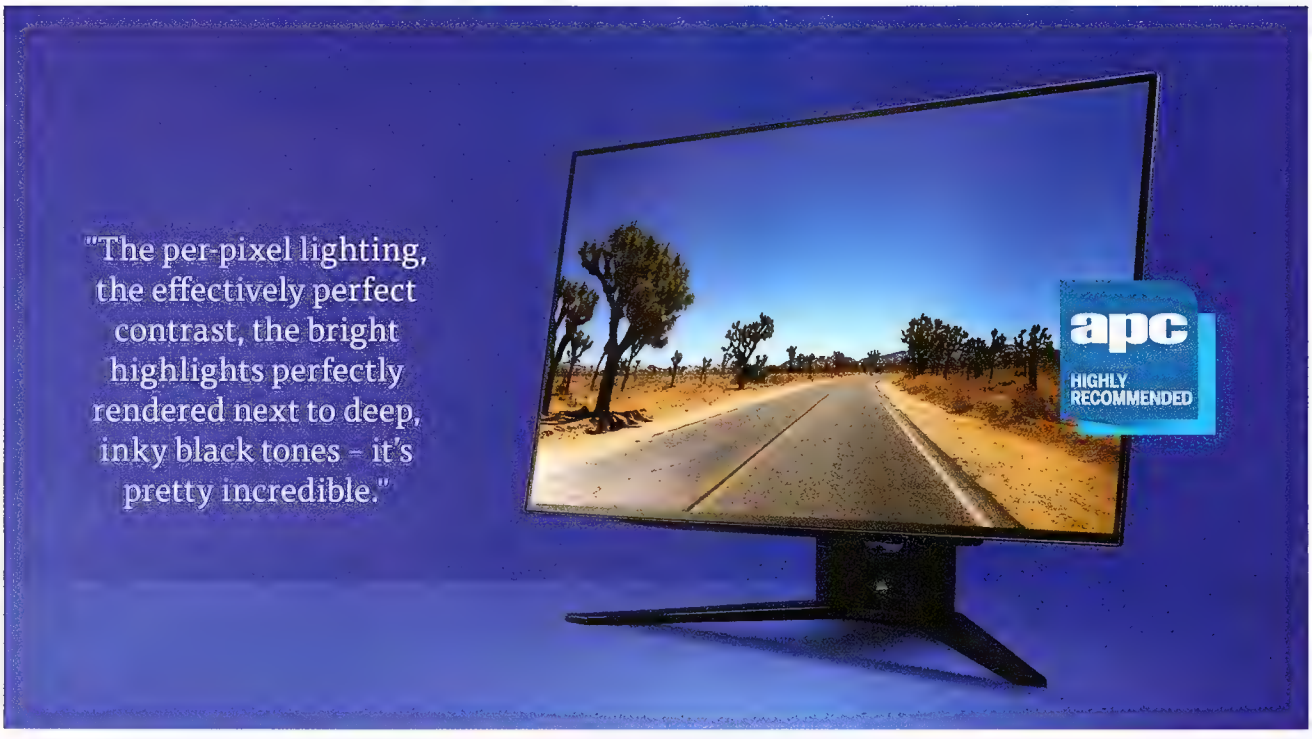
★★★★½

MONITOR

Corsair Xeneon 27QHD240

As good as 1440p gets, but at a price.

■ $1,899 | corsair.com


"The per-pixel lighting, the effectively perfect contrast, the bright highlights perfectly rendered next to deep, inky black tones – it's pretty incredible."
apc
HIGHLY RECOMMENDED

■ Panel size: 27-inch; Panel type: OLED; Resolution: 2560 x 1440; Brightness 1000 nits peak; Response time: 0.03ms; Refresh rate: 240Hz; Contrast ratio: 1M:1; Features: LG WOLED panel, 98.5% DCI-P3, adaptive sync, 1x DisplayPort 1.4, 2x HDMI 2.1, USB-C with power delivery.

You can buy OLED PC monitors from a growing list of brands. Ultimately, however, the actual OLED panels that go into those screens are sourced from just two companies: LG and Samsung. It's the former that provides the 27-inch OLED panel in the new Corsair Xeneon 27QHD240. Unfortunately, that's an issue.

Hold that thought while we cover speeds and feeds. This 27 incher runs the same 1440p native resolution as similar OLEDs from Asus and LG. They use the same LG WOLED technology and offer similar specifications. Corsair rates the panel at 0.03ms for pixel response, with peak brightness at 1,000 nits.

Again, that's some serious punch, though it only applies to a three percent or smaller window and Corsair doesn't quote full-screen brightness, the latter arguably being what you want to know. Typically, the full-screen brightness of all OLED panels and LG panels in particular is dramatically below the peak brightness achieved in a small portion of the panel.

The refresh rate comes in at 240Hz, which is plenty, and the colour coverage is rated at 98.5 percent of the DCI-P3 digital cinema gamut.

It's wrapped up in a nicely put-together chassis that goes some way to justifying the price, but that's the norm for OLED monitors now. They look like poor value when you can get a much larger 4K OLED TV for about the same price.

Anyway, the most important measure is image quality, and that's where we come back to the limitations of current LG OLED technology. The problem is brightness and how that translates into typical PC usage, as opposed to watching video content on an OLED TV. For the latter, the fact that the panel's peak brightness varies so much depending on how much of the screen is being lit up is tolerable. Indeed, often it's hard to notice.

On the Windows desktop, it's obvious if the panel brightness nosedives when you do something routine like opening a browser window with a predominantly white background. It's just so clunky. You can, of course, disable the ABL (automatic brightness limiter), but that just has the effect of running the display at the lowest common brightness denominator.

That's less than 200 nits, at which point you've paid $1,900 for a 27-inch 1440p panel. In games, brightness is less of an issue. In darker scenes punctuated by small, bright objects, it's easy to see what the fuss is regarding OLED technology. The per-pixel lighting, the effectively perfect contrast, the bright highlights perfectly rendered next to deep, inky black tones – it's pretty incredible.

But even in games, the full-screen limitations can be obvious. The bright desert scenes in *Cyberpunk*, for instance, can look dingy. The panel's brightness drops off when the majority of the screen is showing something bright.

That's a pity, because in many other regards, this is fabulous. It's fast, beautifully built, and nicely calibrated. But at this price, and taking into account the modest panel size and resolution, putting up with either the clunky ABL or a pretty dim display is hard to swallow. That's particularly true when you can grab one of a number of 34-inch ultrawide OLED monitors based on Samsung's QD-OLED tech that all do full-screen brightness much better and tend to have much less intrusive ABL algorithms.

Very pacey OLED panel with sometimes super HDR performance, though super expensive for a 1440p panel, and with poor full-screen brightness.

Jeremy Laird

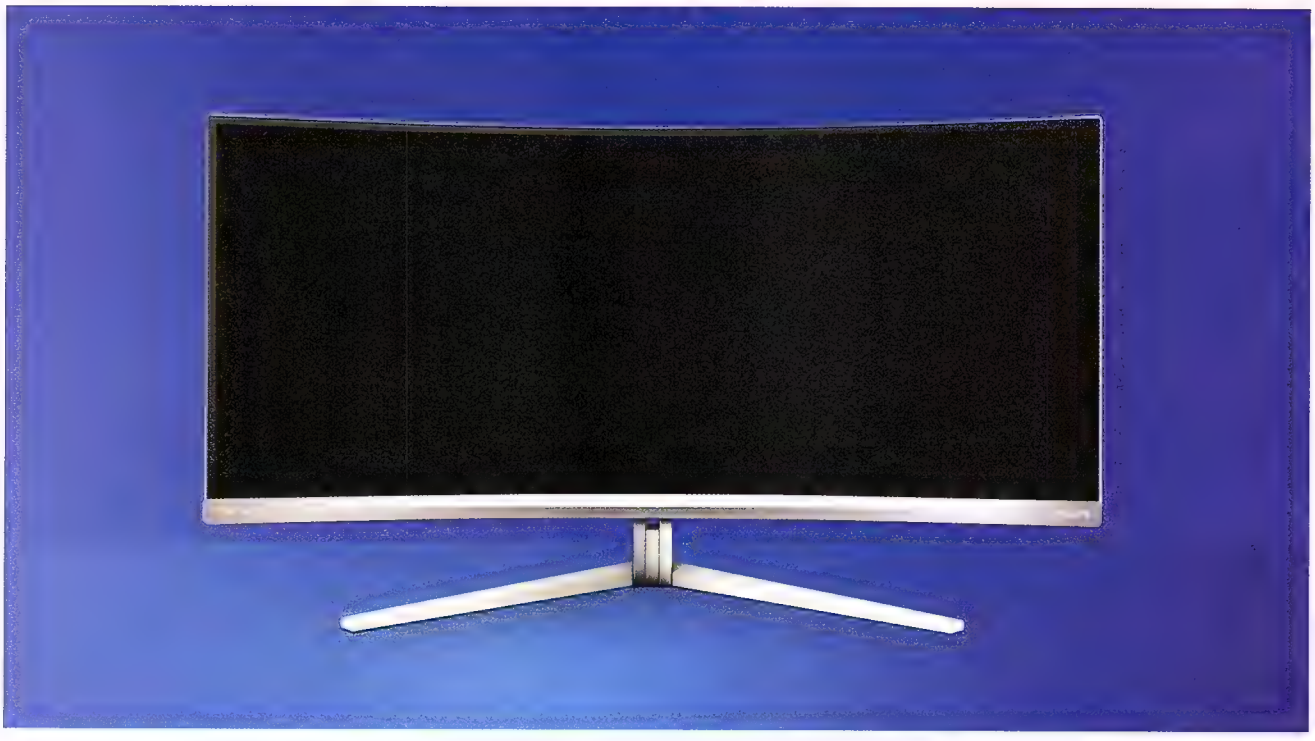
★★★★☆

MONITOR

Philips Evnia 34" UWQHD QD-OLED curved gaming monitor

Samsung's QD-OLED ultrawide keeps getting more affordable and so this awesome monitor continues to hold a competitive edge.

■ $1,499 | www.philips.com.au



■ 34-inch QD OLED display at 3440 x 1440 pixel resolution; 175Hz, 0.03ms response rate; Adaptive sync; Vesa DisplayHDR 400 True Black, 99.3% DCI-P3, 148.8% sRGB; 1800R curve; 2 x HDMI2.0, DisplayPort 1.4, USB-C 3.2 Gen1, USB-B upstream, audio jack; 15cm height adjustment, +/- 20-degree swivel, -5 to +20-degree tilt; 81.3 x 55.3 x 29.5cm; 8.7kg.

In the last issue we covered a 34-inch ultra-wide 1440p monitor with a 165Hz refresh rate from Asrock that retails for just $619, so it might be a little confusing that a seemingly comparable, 34-inch ultra-wide display from Philips costs almost three times as much.

The most fundamental answer is that the Asrock monitor opts for a VA display, while the Evnia 34" UWQHD QD-OLED here combines a notoriously expensive OLED panel with novel Quantum Dot lighting technology. We first saw the combination of these two technologies in the 2022 Alienware AW3423DW, which was our favourite monitor of last year, and it's actually the exact same Samsung panel as the one used here by Philips.

"Despite its professional capabilities, there's no doubt this is a gaming display since it offers a 175Hz refresh rate and 0.03ms response rate."

We've actually covered subsequent releases of this panel from both Samsung and MSI in the pages of this mag, so you can get just about any variation of this display as you want. The main point of difference with the Philips device is the price, which now retails for $1,499 on sale, cheaper than any of the other comparable offerings by at least $200.

This is a pretty impressive monitor for that price. The 3440 by 1440 pixel resolution is great for working across multiple documents and it offers a nice balance of resolution and frame-rate for gamers that want their games to look as good as possible. It's also bright for an OLED, offering VESA Display HDR 400 True Black certification and a typical HDR brightness of 450 nits, which is as bright as many comparable LED monitors will offer without the deeper blacks of OLED.

If you do need to do professional colour work the display meets 99.3 percent of the DCI-P3 colour gamut and 97.8 percent of AdobeRGB. It also achieves a Delta E of less than 2, which is very much playing in the ballpark for pro colour work (at least for some).

Despite its professional capabilities, there's no doubt this is a gaming display since it offers a 175Hz refresh rate and 0.03ms response rate, which will be more than enough for any gamer – other than maybe those who actually get paid to play competitively. It doesn't offer additional AMD or Nvidia screen syncing capabilities, which you will get to varying degrees on Alienware, MSI or Samsung's offerings. This will be a little disappointing considering the potential for high-refresh HDR gaming. But that can be a fickle luxury that's only available on select games anyway, so we suspect this will be an acceptable concession for many.

There are similarly priced 34-inch ultra-wide curved offerings from Acer and Asus, but while they might offer fractionally higher refresh rates and similar colour specifications, neither of these standard-LED displays can compete with the additional contrast offered by an OLED panel like the one on the Philips Evnia 34" UWQHD QD-OLED curved gaming monitor.

It's hard to compete with the vibrancy of this QD-OLED panel... even more than a year after its initial launch.

One of the best looking and most balanced gaming monitors you can buy at a more affordable price.

Joel Burgess

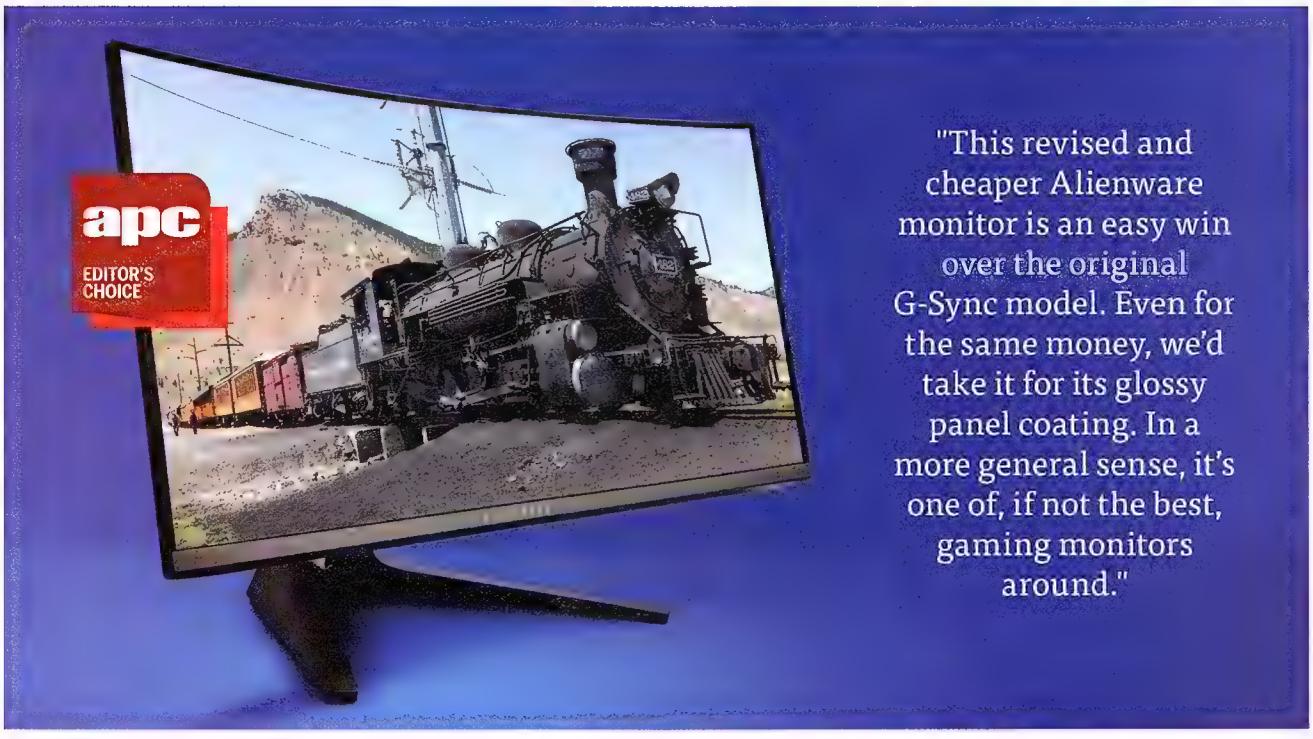
★★★★½

MONITOR

Alienware 34 AW3423DWF

The best just got better – and cheaper.

■ $1,448 | dell.com


apc
EDITOR'S CHOICE
"This revised and cheaper Alienware monitor is an easy win over the original G-Sync model. Even for the same money, we'd take it for its glossy panel coating. In a more general sense, it's one of, if not the best, gaming monitors around."

■ Screen size: 34-inch; Panel type: QD-OLED; Resolution: 3,440 x 1,440; Brightness: 1,000 nits; Contrast: 1M:1; Response time: 0.1ms; Refresh rate: 165Hz; Colour coverage: 99.3% DCI-P3; HDR support: DisplayHDR 400 True Black: Adaptive sync: FreeSync Premium Pro, G-Sync Compatible; Connectivity: DisplayPort 1.4 x2, HDMI 2.1, USB-A hub.

Not only is Alienware's alternative OLED monitor, the Alienware 34 AW3423DWF, better than the existing AW3423DW; it's cheaper. How does that work, exactly? For the most part this is the same monitor, so it's a 34-inch ultrawide model sporting Samsung's QD-OLED technology. It's not just the same technology; it's the same panel, with one alteration, more on which momentarily.

Once again, the resolution is 3440 by 1440, the peak brightness remains at 1,000 nits, the claimed pixel response of 0.1ms is carried over, and so on. There are one or two detail changes, and the refresh rate has been dropped from 175Hz to 165Hz. There's likely no technical reason for this ultimately inconsequential change. Instead, Alienware is probably putting a bit of on-paper space between the two screens to justify the price gap.

The same essentially applies to the other major omission: the Nvidia G-Sync Ultimate chip. You don't get it with this cheaper panel, and it really isn't any loss. There's still full adaptive refresh support courtesy of AMD FreeSync Premium Pro, which is compatible with both AMD and Nvidia GPUs. You just don't have to pay for that pricey Nvidia G-Sync chip.

As for the rest of the feature set, you get the same dual-DisplayPort and HDMI video interfaces and slightly old-school USB-A hub. There's no USB-C connectivity, so no single-cable option for laptops.

So what's that tweak? Nothing terribly high-tech: a glossy anti-glare coating for the OLED panel. The OG AW3423DW variant runs a matte coating, and robs the panel of punch, vibrancy, and contrast. You don't get the full deep-and-inky black experience with a matte coating.

But a glossy coating fixes all that, and really lets the OLED panel sing. Subjectively, the contrast takes a big leap, and the upshot is the kind of experience you're hoping for from OLED. What hasn't changed, and it's a good thing, is that Samsung's QD-OLED tech is currently a better fit for the PC, as opposed to TVs than LG's WOLED alternative. Samsung's panels have better full-screen brightness, and don't suffer as much from brightness limiter algorithms bumping the brightness around as you conduct basic tasks in Windows.

In comparison to LG-powered OLED monitors, including the Corsair Xeneon Flex, this Alienware serves up a relatively compromise-free experience. You can enjoy the upsides of OLED technology, including better HDR performance than any LCD monitor, and the best pixel response, but without the flaws of LG-equipped monitors.

This revised and cheaper Alienware monitor is an easy win over the original G-Sync model. Even for the same money, we'd take it for its glossy panel coating. In a more general sense, it's one of, if not the best, gaming monitors around.

Shop around, and you can get something good for as little as $700, such as the Asrock Phantom PG34WQ15R2B. Is this Alienware really three times the experience? No. It's probably not even twice the experience. Similarly, at this price, all manner of 4K and mega-sized monitors are available. But as a gaming experience, this is as good as it gets, and the best is never cheap.

Glossy coating make all the difference. Samsung OLED tech rocks.

Jeremy Laird

★★★★☆

SSD

Seagate FireCuda 540 2TB SSD

High performance and peace of mind at a very steep early adopter price.

■ $589 | seagate.com

PCIe 5.0 SSDs have been teased for what seems like an eternity. In spite of all the chat, relatively few drives are available, even less so from the big name SSD makers. Seagate belongs in that category, and its FireCuda 540 leads the Seagate charge into the brave new world of PCIe 5.0 SSDs.

For now, that new world is a very expensive one to buy into. All PCIe 5.0 SSDs carry a massive price premium over PCIe 4.0 drives. There are many high performance 2TB PCIe 4.0 drives at well under half the price of the 2TB FireCuda 540, and straight away that makes it difficult to recommend.

Seagate is positioning the FireCuda 540 as an all-round option. There are obvious gaming benefits, including support for DirectStorage, but it also carries an excellent endurance rating and comes with three years of data recovery support. That kind of support and peace of mind will appeal to professionals, and they're less likely to worry over price if you think of Seagate's impressive warranty as a service.

The Firecuda 540 includes the latest and greatest 232-Layer Micron TLC NAND plus 4GB of LPDDR4 memory. Seagate opted not to pursue maximum performance at all costs in favour of a good blend of performance and reliability, and this is one of the major points in the FireCuda 540's favour.

With a 2000 TBW endurance rating for the 2TB drive, Seagate is clearly confident in the reliability of the drive. Add to that a five year warranty with a three year data rescue plan and this is a drive that will not only appeal to gamers, but professionals and networked storage users alike.

The performance of the FireCuda 540 is a bit of a mixed bag. There's a reason vendors like to push sequential performance as the most important measure of an SSD's performance. The FireCuda does really well here. The superior controller, 232-layer NAND, DRAM and cache all give the FireCuda 540 a huge advantage over previous generation drives in sequential performance and internal file transfer speed. Simultaneously reading and writing 30GB made up of over 25,000 files in 50 seconds is impressive.

But sequential performance is only part of the story. The FireCuda still outperforms PCIe 4.0 drives in random tasks, but not by anywhere near as much as you'd maybe hope given the price differential. And when it comes to the real perception of responsiveness, you really won't notice any difference.

At well over twice the price of the best PCIe 4.0 drives, PCIe 5.0 SSDs are a tough sell. Seagate is not alone here. They're all too expensive. A look at the few PCIe 5.0 drives that are available puts them all around the same price. So in relative terms, at $589 the 2TB FireCuda 540 isn't unreasonably priced.

In six months time, maybe we'll be able to recommend the FireCuda 540 in terms of value, as well as performance, but for now it's a real struggle.

"There are many high performance 2TB PCIe 4.0 drives at well under half the price of the 2TB FireCuda 540, and straight away that makes it difficult to recommend."

	Seagate FireCuda 540 (Gen5)	Team Cardea A440 (Gen4)
Crystal Disk Mark - Sequential Read MB/s	10,081	7,208
Crystal Disk Mark - Sequential Write MB/s	10,196	6,765
Internal File Copy - 30GB of mixed file sizes - Time (seconds)	51	106
3DMark Storage Benchmark - Score	3,942	2,813
Total Loading Time (seconds) - Score	6.56	7.81
Peak Temp	80	71

Given the huge prices of PCIe 5.0 drives, the Seagate FireCuda 540 doesn't make a lot of real world sense, but if you want an ultra fast SSD with an excellent endurance rating and warranty, why not?

Chris Szewczyk

★★★½☆

MOTHERBOARD

Asrock Z790 Taichi Lite

A flagship motherboard at a price that can't be beat.

■ $729 | asrock.com

The concept behind the Asrock Z790 Taichi Lite is simple. It retains all of the features of its non-Lite counterpart, but drops the premium aesthetic, knocking over $150 off the price in the process.

Looks aside, the Z790 Taichi Lite retains all of the premium features of the Z790 Taichi. Its long feature list includes dual Thunderbolt 4 Type-C ports, high-end audio and VRM solutions, lots of storage capacity and dual LAN. There's no other motherboard in the Z790 Taichi Lite's price range that ticks all of those boxes.

The Z790 Taichi Lite still has some RGB lighting. The white printed cogs and wheels combined with a primarily black design is not ugly, but it does give it a mid-tier, almost utilitarian appearance.

The Z790 Taichi Lite is an E-ATX board with plenty of highlights. You get a total of eight fan headers making this a water-cooling friendly board. Just below the bottom M.2 heatsink is a series of RGB LEDs, and there are four more RGB headers too, three of which are addressable.

The board comes with five M.2 slots, though only four can be used at a time. That might seem odd, but the twin primary slots can be used with either a PCIe 4.0 or a PCIe 5.0 drive. It means a PCIe 4.0 drive can benefit from the enlarged heatsink, while leaving the PCIe 5.0 x16 slot at full speed. When the PCIe 5.0 M.2 slot is populated, the primary x16 slot drops to x8.

The VRM is a real highlight. It's a 24-phase design with 105A stages cooled by big chunky heatsinks. The Z790 Taichi Lite will happily power a liquid nitrogen cooled Core i9 13900K without breaking a sweat, and it'll handle any upcoming refreshed K model under the same conditions.

The audio section is top notch. A Realtek ALC4082 codec is matched with an ESS Sabre 9218 DAC and WIMA capacitors. It'll be hard to find a better integrated solution.

The networking capabilities of the board are a bit hit and miss depending on what you need. Intel WiFi 6E is joined by Killer E3100G 2.5G and Intel I219-V 1G wired LAN ports. These will appeal to those requiring dual LAN, but I'd like to see 5G, if not 10G.

Onto the results then. The Z790 Taichi Lite throws up no surprises. It puts up good multithreaded results and its PCMark results and 3DMark Storage score show it to be a good all-rounder. There's little to worry about when it comes to gaming either.

The Asrock Z790 Taichi Lite is a refreshing change in a market that has seen nothing but price increases over the last few years. Spending $1,500 on a motherboard before even considering a GPU, memory and CPU is a tough pill to swallow when you can get a console for a fraction of the overall price. I really hope other motherboard manufacturers sit up and take notice. Sometimes less really is more.

It's a board that's packed with high end hardware. Apart from 10G LAN and some extras like a PCIe M.2 add-in card or integrated LCD, there's really not that much more to add. And boards that do have those things are definitely not priced at $729.

"Its long feature list includes dual Thunderbolt 4 Type-C ports, high-end audio and VRM solutions, lots of storage capacity and dual LAN."

	Asrock Z790 Taichi Lite	Gigabyte Z790 Aorus Master
Cinebench R23 - Multi thread Score	39,891	40,368
Blender 3.3 Whitelands - Time (seconds) Lower is better	417	414
7Zip 22.01 - Billion Instruction per second	198.65	200.37
Handbrake 1.6 - Video conversion 4K to 1080p FPS	149.1	147.9
Ghost Recon: Breakpoint - 1080p, Low, Avg FPS	305	304
Civilization VI - 1080p, Lowest Preset, Avg FPS	435	434
3DMark TimeSpy Extreme - Score	18,298	17,938

This is a motherboard that offers excellent value for money that nothing in its price range can match.

Chris Szewczyk

★★★★½

SMARTPHONE

Google Pixel Fold

Has Google perfected the foldable phone, and does Samsung have cause to worry?

■ 256GB, US$1,799 (~AUD$2,750) | store.google.com

■ 8-core Google Tensor G2 processor; 12GB RAM; Mali-G710 graphics; 7.6in foldable 120Hz AMOLED screen, 1,840 x 2,208 resolution; 5.8in cover 120Hz AMOLED screen, 1,080 x 2,092 resolution; 5G; 256GB/512GB storage; IPX8 rating; 48MP rear camera; 9.5MP front camera; 8MP inner camera; Wi-Fi 6E; Bluetooth 5.2; NFC; 4,821mAh battery; USB-C 3.2 Gen 2; Android 13 with 5yr Pixel updates; folded, 80 x 12.1 x 140mm (WDH); unfolded, 159 x 6.3 x 140mm (WDH); 283g; 2yr warranty.

It's about flippin' time. At last, another mainstream foldable phone is here to compete with Samsung's Galaxy Fold handsets. And this is no me-too device: the Pixel Fold makes its own mark with a wide front display that's easy to use, the thinnest design we've seen on a foldable and top-grade cameras.

First things first, though. At the time of writing the Pixel Fold Australian release date hasn't been announced. It may not even make it to our shores, but with the staggered territorial roll outs we've seen in the past from Google, the chances are extremely high it will have an Australian release, and soon.

Design and displays

The Pixel Fold is available in two colours: Porcelain and Obsidian. I personally prefer the Porcelain model as it "pops" more, but the black model has a sleek executive vibe going for it. The design feels impressively mature for a first attempt. It all starts with a front 5.8-inch display, which in my view works better than the narrower cover panel on the Galaxy Z Fold 4. The wider aspect ratio makes it easier to use apps and type on the front panel: this is not a preview display, but a true second display.

There's also no gap for debris to get in when the phone is closed, and Google claims its fluid-friction hinge is the most durable available on a foldable. Time will tell on that, but I can say right now that it's super smooth in operation.

Once opened up, the phone measures 6.2mm thick, and while that's officially only 0.1mm thinner than the Fold4, it somehow feels palpably slimmer. The Pixel Fold's dual OLED displays both offer plenty of colour, wide viewing angles and perfectly smooth 120Hz refresh rates. I greatly enjoyed watching movies across the combined 7.6in screen. However, while it looks great indoors, but it can struggle a little when in direct sunlight. We measured a maximum brightness of 1,000 cd/m2 – well below the 1,500cd/m2 claimed by the single-screen Pixel 7 Pro. Still, it's ahead of the Galaxy Z Fold4, which peaked at 905cd/m2.

> "First things first, though. At the time of writing the Pixel Fold Australian release date hasn't been announced."

There are a few negatives about the Pixel Fold. At 283g it's a touch heavier than the Z Fold4's 263g: you can pop it in your shirt pocket, but expect it to sag. And while it folds out mostly flat, I wouldn't say perfectly so. That's just irritating for a premium device.

The bezels around the internal display are also a little on the thick side, although once you're immersed in content you don't notice it so much. And while the crease in the middle of the screen isn't too conspicuous, especially under indoor lighting, you'll feel it when you drag your finger across the display.

Finally, we've heard some early accounts of Pixel Fold units suffering screen damage, including debris getting caught between the bezel and screen protector. It's perhaps telling that Google makes no claims about dust-resistance, although an IPX8 rating indicates that the Pixel Fold should withstand the occasional accidental dunk in water. It's not that sturdily assembled, either – reportedly

the phone can be easily broken by bending it backwards. However, Google is teaming up with iFixit to offer genuine spare parts and repair guides, so if something does go wrong you may be able to fix it yourself.

Software and usage modes

The Pixel Fold makes multitasking a breeze. There's a dock you can pull up with a quick swipe, and you can easily run apps side by side by just dragging an app to either side of the screen. As with the Pixel Tablet, content can be dragged from one side of the display to the other, such as dropping photos into outgoing messages or emails. It all feels clean and intuitive.

And there's a good selection of apps optimised for the Pixel Fold's big screen. Gmail is great on this device, as I like being able to see my inbox on the left and the content of my messages on the right. I also appreciate that TikTok lets you view videos and comments side by side, and Spotify has some similarly nice dual-pane action. Half-unfold the phone and you can use it like a laptop, with compatible apps showing content at the top and controls on the bottom; I tried this while following along with a workout in the Peloton app and found it worked well.

Other supported configurations include tent mode – great for watching videos hands-free while you're doing other stuff – and tabletop camera mode, which lets you stand the phone up without needing a tripod. It's ideal for time-lapse photos and video capture, plus of course ad-hoc video calls.

"It comes with a trio of rear cameras, comprising a 48MP main sensor, a 10.8MP ultrawide shooter and a 10.8MP telephoto lens with a 5x optical zoom."

If there's one improvement I'd like to see in this area it's more control over which apps can run on the front screen when the Pixel Fold is closed. Right now only certain apps continue on the cover display, such as Google Maps and YouTube. I also noticed some occasional slight bugginess: at one point, the camera app got stuck in a vertical aspect ratio and I had to open and close the app. Other times the Pixel Fold got confused when I tried to change modes and the screen would briefly stutter. I'm assuming software updates will iron out these kinks.

Cameras

We've come to expect great photo quality from Pixel-branded phones, and the Pixel Fold doesn't disappoint. It comes with a trio of rear cameras, comprising a 48MP main sensor, a 10.8MP ultrawide shooter and a 10.8MP telephoto lens with a 5x optical zoom. Up front, there's a 9.5MP camera, and the inside of the Fold houses another 8MP lens.

Together these cameras deliver plenty of flexibility, allowing you to capture excellent images of all kinds. I took some stunning shots, including a

PHOTO SAMPLES

If you love to snap photos of food (we won't judge) then you'll be extremely happy with the Pixel Fold's close-up capture of colours and textures.

There isn't a dedicated macro lens, but in practice the 48MP main sensor does an excellent job when it comes to close-up focus and details.

This is a sharp-shooting camera, as shown by how well it captures the falling water from the fountain (arguably better than an iPhone 14 Pro Max).

close-up of a daisy fleabane flower, a sharp photo of a fountain and a majestic view of twin buildings with a rippling reflection in the pond.

I also tested out the optical zoom by shooting the top of a skyscraper at 5x zoom, and found the Pixel Fold did a very good job capturing the striations in the stone part of the spire and details in the building. And Google's Night Sight processing makes this phone a champ in low light, as I found when shooting a solar-powered lantern. The Pixel delivered a lovely bright image, with light reflecting off the concrete below; the same shot taken on a Samsung Galaxy S23 was dimmer overall, and lacking in background detail.

As for video, the Pixel Fold can capture colourful 4K 10-Bit HDR footage at up to 60fps. In all,

I'd rank this handset among the best camera phones on the market – I preferred many of its images to ones shot on the iPhone 14 Pro Max or the Samsung Galaxy S23 Ultra.

Performance

The Pixel Fold packs the same Tensor G2 chip as the Pixel 7 and Pixel 7 Pro. It's a fine chip, but don't expect best-in-class horsepower. In the Geekbench 6 benchmark, which measures overall performance, the Pixel Fold turned in a single-core score of 1,390 and a multi-core score of 3,291.

That's only a little behind the Galaxy Z Fold4, but then that phone is using a year-old Snapdragon 8 Gen 1 CPU. By the time you read this, it's expected that the new Galaxy Z Fold5 will have emerged, using the faster Snapdragon 8 Gen 2. For context, that same chip inside the Galaxy S23 achieved around 2,000 in the single-core test, and over 5,000 for multi-core. The iPhone 14 Pro Max is even faster at over 2,500 and 6,300.

The Pixel Fold trails competing flagships in graphics performance too. When it comes to transcoding video, it lagged behind the Galaxy Z Fold 4 by 15 seconds and the iPhone 14 Pro Max by 30 seconds.

Let's not get too hung up on comparisons, though. In daily use I found the Pixel Fold perfectly responsive and snappy, whether I was surfing the web and flipping between tabs or racing around in Asphalt 9. The Call of Duty Mobile experience was fairly fluid as well: even with multiple enemies on screen trying to mow me down the action remained smooth. Very few people will need more power than this.

Battery life and charging

The Pixel Fold's 4,821mAh battery should be satisfactory for most people. On one day of testing I began using the Pixel Fold at 7am, and spent the rest of the day sporadically taking photos, surfing the web and playing games. When I set it down at around 10pm I had 28 percent battery capacity left.

In our web-surfing battery test, the Pixel Fold lasted 10 hours and 21 minutes in 60Hz display mode. That's pretty good, considering that the Galaxy Fold4 averaged 9hrs 17mins with the same display settings. The best phones can manage more than 11hrs 30mins, but foldables have twice as many panels to power. And when your battery does get low, the Google Pixel Fold supports 30W wired charging as well as Qi wireless charging.

Conclusion

The Google Pixel Fold is a very expensive smartphone, but there's a lot to like about it. In fact, it's the first foldable phone I could really see myself using on a daily basis. I love how easy it is to run two apps side by side, the elegant dock, and the multiple usage modes like tabletop and tent. You really feel like you're getting a tablet experience in a pocket-sized phone.

It also feels like you're getting durable, polished hardware for the money, with a great set of cameras. The wider cover display makes a big difference too. While the Pixel Fold isn't quite perfect, it's a stellar phone that deserves serious consideration from anyone interested in a foldable handset: Samsung should be nervous.

The Pixel Fold delivers with a thin and durable design, wide front display, smart software and great cameras.

Mark Spoonauer

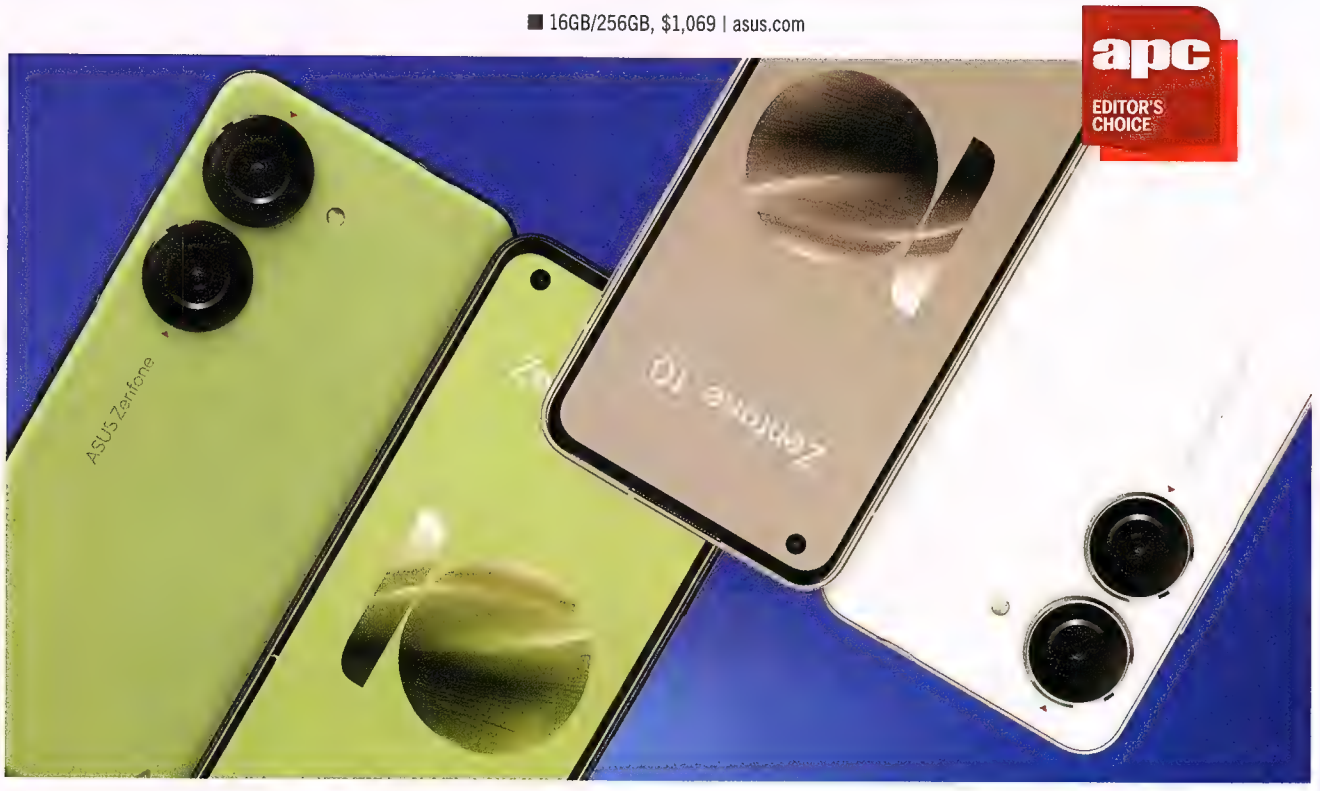
★★★★☆

SMARTPHONE

Asus Zenfone 10

The best sub-6in smartphone you can get right now.

■ 16GB/256GB, $1,069 | asus.com



■ 8-core (3.2GHz/2.8GHz/2GHz) Qualcomm Snapdragon 8 Gen 2 SoC; 8GB/16GB RAM; Adreno 740 graphics; 5.9in 144Hz AMOLED screen, 1,080 x 2,400 resolution; 5G; 256GB/512GB storage; dual 50MP/13MP rear cameras; 32MP front camera; Wi-Fi 7; Bluetooth 5.3; NFC; 4,300mAh battery; USB-C 2 connector; Android 13; 68 x 9.4 x 147mm (WDH); 172g; 2yr warranty.

Asus' Zenfone handsets have always delivered plenty of power at a convenient size, and the new Zenfone 10 doesn't mess with the formula. At $1,069 with 8GB RAM and 256GB storage it makes a compact alternative to the Samsung Galaxy S23. You can pick up a Zenphone 10 from the likes of Dick Smith or Becex Tech in Australia, even though Asus hasn't officially launched it here yet.

This is a phone with a character of its own. The 5.9in format is smaller than most Android phones these days, and the handset weighs just 172g. That's partly down to a bio-polycarbonate back. Despite the plastic build the Zenfone 10 doesn't feel cheap: indeed, its nice grippy texture is ideal for one-handed operation. It's also good to see a 3.5mm headphone jack on the top edge, and despite this big hole in the Zenfone's body, the handset still offers IP68-certified dust and water resistance.

The Zenfone 10's distinctive shape gives the screen a tall 9:20 aspect ratio, with a native resolution of 1,080 x 2,400. Although the AMOLED isn't the brightest or most colour-accurate we've seen, its 120Hz refresh rate – optionally rising to 144Hz in supported games – ensures everything flows smoothly, perhaps a little more so than on the Pixel 7 with its 90Hz peak.

Asus hasn't skimped on the internals either. The Zenfone 10 uses the same Snapdragon 8 Gen 2 chipset as the Galaxy S23, enabling it to broadly match the Samsung's excellent benchmark results. And in our 4G web-browsing test the Zenfone's 4,300mAh battery and smaller screen helped it last more than two hours longer than the S23 – and more than five hours longer than the Pixel 7.

In use, the Zenfone 10 software feels like stock Android, but with a few unique Asus customisations. The power menu, volume controls, lock screen and quick settings all present more options than normal Android, and additional shortcuts can be accessed by swiping on the fingerprint-reading power button. I like using this feature to open and close the notification shade; you can alternatively use it to scroll up and down web pages or scrub through YouTube videos.

A big compromise is the camera hardware. This isn't terrible: the 50MP main camera is joined by a 13MP ultrawide camera, and an unexpectedly high-res 32MP camera on the front. However, there's no telephoto lens as on the Galaxy S23, nor the sort of AI-powered processing found on the Pixel 7.

In my tests I found that the Zenfone produced bold images with plenty of contrast, but results weren't as bright or vibrant as shots from the Samsung Galaxy S23. The all-digital zoom has a tendency to produce slightly soft photos, and while selfies looked generally warm and detailed, the Portrait shooting mode didn't do a perfect job of separating me from the background. The one standout feature is a six-axis hybrid gimbal system for optical stabilisation, which did a good job of minimising the bobbing effect when I tried shooting video while walking around.

Even if the Zenfone 10 can't quite equal the photographic capabilities of the Samsung Galaxy S23, it's a smartly designed phone that's a pleasure to use. There's enough processing power here for any task, and a battery that's big enough to ensure you won't run out of juice half-way through your day. If you're looking for a sub-six-inch Android phone you won't do better.

Limited cameras, but this compact Android phone is packed with power and offers excellent battery life.

Richard Priday

★★★★★

SMARTPHONE

Motorola Razr 40 Ultra

Three times has been the charm for Motorola's foldable design.

■ $1,499 | motorola.com.au

apc HIGHLY RECOMMENDED

■ 8-core 3.19GHz/2.75GHz/1.8GHz Qualcomm Snapdragon 8+ Gen 1; 8GB RAM; Adreno 730 graphics; 6.9in foldable 120Hz AMOLED screen, 1,080 x 2,640 resolution; 3.6in AMOLED cover screen, 1,066 x 1,066 resolution; 256GB storage; IP52; dual 12MP/13MP rear cameras; 32MP selfie camera; 5G; Wi-Fi 6E; Bluetooth 5.3; USB-C 2 connector; 3,800mAh battery; Android 13; open, 74 x 7 x 171mm (WDH); closed, 74 x 15.1 x 88mm (WDH); 185g; 1yr warranty.

Alongside a growing number of foldable phones, we're starting to see more "flippable" vertical designs. Last year's Motorola Razr was a credible competitor to the Samsung Galaxy Z Flip 4, now the Razr 40 Ultra is a bigger, more substantial offering, with a larger external display and a stylish look that will definitely turn heads. Is this the phone to bring the flip concept into the mainstream?

As you'd expect, the phone is terrifically pocketable when it's folded up. A pleasingly solid hinge mechanism allows the Razr 40 Ultra to close up completely with no gap, then sit flush when it's opened up. While there is a small crease running along the inside display, I barely noticed this when using the phone.

In either configuration the Razr 40 Ultra is easy to hold and operate, measuring just 6.9mm thick when opened up and weighing 189g. Around the right side, the dedicated power button doubles conveniently as a fingerprint sensor. Given the design challenges involved, Motorola has done an incredible job with the engineering: frankly, there's no better looking or feeling foldable than this. Just note that the Razr 40 Ultra's IP54 rating means it can withstand minor splashes of water, but not submersion.

> "In either configuration the Razr 40 Ultra is easy to hold and operate, measuring just 6.9mm thick when opened up and weighing 189g."

Displays

The front of the Razr 40 Ultra is almost entirely taken up by a square 3.6in OLED display. There are lots of ways to personalise what runs here, including a variety of clocks, animated wallpapers and much more. But this screen isn't just for decorations: it has the same pixel density as the main display, and I was able to run many apps and games on it. Since the panel is almost as wide as the internal screen, I could even use the virtual keyboard to easily type out messages on the front panel, without needing to open up the phone at all.

Not all apps work properly on the outer display, mind you. Gmail and Google Maps were fine, but surfing the web with Chrome was problematic with the limited view, and one game I tried playing on the external display looked squished.

When it's time to open up, the main 6.9-inch display is just as pleasing. It's gloriously bright, with a peak brightness of 1,084cd/m2 – well ahead of the Samsung Galaxy Z Flip 4's maximum of 772cd/m2. This being an OLED panel, it offers wide viewing angles with minimal distortion and punchy colours. Coupled with a fluid 165Hz refresh rate, that makes it excellent for watching videos and playing games.

Both internal and external displays are covered with Corning Gorilla Glass Victus, which provides some defence against casual scratching. I've been carrying it around in my backpack and pockets, and it has yet to pick up a mark.

System software

The Razr 40 Ultra runs Motorola's own version of Android 13, which deviates

little from stock Android. For example, the Razr 40 Ultra comes with Google Photos instead of a manufacturer-branded gallery app.

There are, however, a few customisations that exploit the flip format. For example, if you fold the Razr 40 Ultra into an L-shape while using the camera app, the controls move onto the bottom screen, while the top becomes a dedicated viewfinder. And if you open the phone up while using an app on the outer display it'll seamlessly jump to the inner display. I enjoyed being able to launch Instagram on the external display, then unfold the phone to continue on the main screen – and vice versa. It really helps the flip format seem natural and useful.

Cameras

The Razr 40 Ultra has a dual-camera system, comprising a 12-megapixel f/1.5 main camera and a 13-megapixel ultrawide f/2.2 module that doubles as a macro camera. There's no zoom or telephoto lens, but that's expected for a flip-phone – the Samsung doesn't have one either.

Generally speaking, the Razr 40 Ultra takes decent photos with natural-looking colours. I wouldn't have minded slightly bolder contrast, or sharper detail from the ultrawide camera, but I've no major complaints. Indeed, I was very taken with the Razr 40 Ultra's macro mode, which encouraged me to see the world in a whole new way. However, slower shutter speeds mean you'll ideally want to shoot in bright conditions and with a steady hand.

The camera's biggest weakness is low-light performance. Even in Night Vision mode I found focusing was unreliable, and tended to produce soft-looking images. When the focus did manage to lock on, details were muddy, with a murky overall colour balance. By comparison, the Samsung Galaxy Z Flip 4's night mode produced a brighter image with more detail.

On the upside, the flip design means you can fold up the external display, turn the phone around and capture full-quality selfies using the rear camera – brilliant for vlogging and recording self-shots. The flip capabilities open up other usage options too: you can fold the display halfway out and hold the phone like an old-school pocket camcorder, and if you're shooting someone else you can have both displays turned on while recording, to give them a live view of what the camera's seeing. Video can be captured at up to 4K at 60 FPS; as with still shots, you'll get the best results when using the main camera under bright conditions.

Overall, I'd say any shortcomings in photo quality are made up for by the sheer utility of the Razr 40 Ultra's folding format.

"The Razr 40 Ultra has a dual-camera system, comprising a 12-megapixel f/1.5 main camera and a 13-megapixel ultrawide f/2.2 module that doubles as a macro camera. There's no zoom or telephoto lens, but that's expected for a flip-phone – the Samsung doesn't have one either."

Performance

The Razr 40 Ultra is built on Qualcomm's Snapdragon 8+ Gen 1 chipset. This isn't the latest and greatest processor – it's already been out for more than a year – but it's the same one as found in the Samsung Galaxy Z Flip 4, and it has plenty of power for all basic functions. I found launching apps and scrolling through the interface was perfectly fluid, and graphically intensive gaming titles like *Modern Combat 5* ran smoothly as well.

I didn't notice much practical difference in battery life between the Razr 40 Ultra and the Z Flip 4: both phones got me through a day of normal usage, and not much more than that.

Conclusion

The flip-phone concept still feels a little experimental, but there's plenty to like about the Motorola Razr 40 Ultra. It looks stylish, it feels impeccably engineered and the large external screen is both fun and useful, enabling this phone to do things that normal non-folding phones can't.

It took Motorola three attempts, but the Razr 40 Ultra is easily the best designed clamshell foldable to date.

John Velasco

★★★★☆

Windows 7, 8.1, 10 or 11 | winaerotweaker.com

WINAERO TWEAKER 1.55

System information tool

We're always pleased when a new version of Winaero Tweaker is released, because it gives us even more ways to make Windows less annoying and intrusive. Since we last looked at this app it's been updated three times, as it strives to keep up with the latest unwelcome changes made by Microsoft.

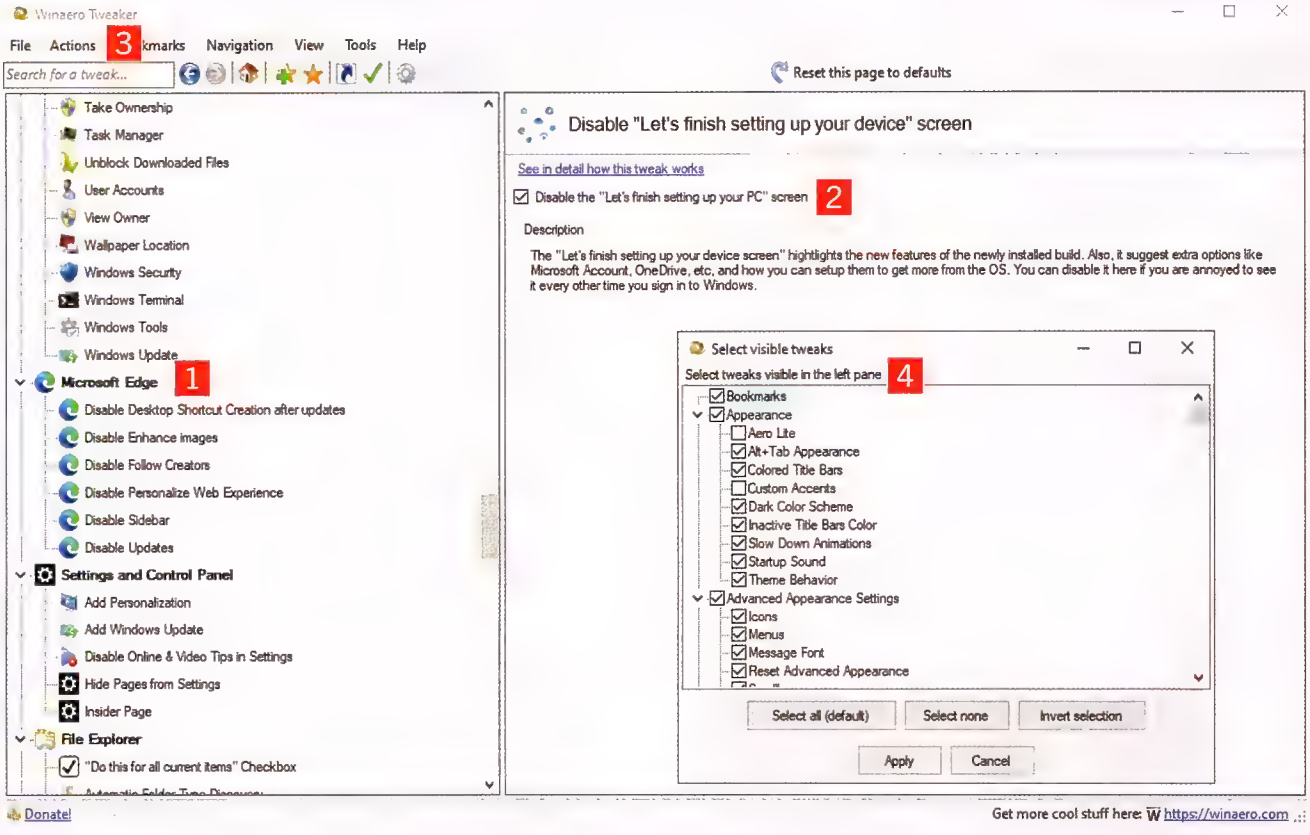
For example, the revamped File Explorer in Windows 11 removes options that many users found useful, so Winaero Tweaker lets you restore them without editing the registry. Scroll down to the File Explorer section in the left-hand panel, click Classic Folder Options and select 'Make the checkboxes removed in Windows 11 visible'. These options include 'Show drive letters', 'Hide protected system files' and 'Use sharing wizard', and you can either restore them all or choose which ones to include.

Other new settings address features in Microsoft's Edge browser that compromise your privacy. These include disabling the 'Follow creators' option, which was found to be sharing details of the sites users visit with Microsoft (**tinyurl.com/APC524fc**), and the 'Enhance images' option, which reportedly sends image URLs to the company (**tinyurl.com/APC524img**). Scroll down to the Microsoft Edge section to change these settings and others related to the browser, such as Disable Sidebar.

> "Since we last looked at this app it's been updated three times, as it strives to keep up with the latest unwelcome changes made by Microsoft."

Winaero Tweaker also now lets you disable the irritating 'Let's finish setting up your device' screen that appears after you install a Windows update – and sometimes randomly when you sign into Windows. You'll find this new option in the 'Boot and Logon' section of the left-hand menu.

Finally, it's worth mentioning that previous versions of Winaero Tweaker triggered a Microsoft Defender SmartScreen warning, but happily this false positive no longer occurs. If it reappears, just click 'More info' then 'Run anyway'.

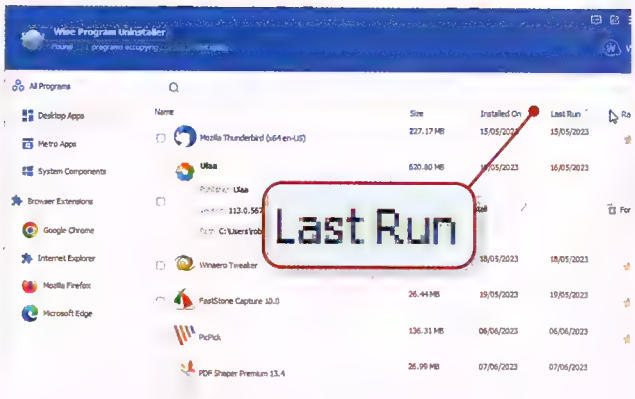


1 Winaero Tweaker now groups all its settings for tweaking Microsoft Edge in one section. These include options for disabling the browser's sidebar, automatic updates and the shortcut it adds to your desktop without asking first.

2 Our favourite new option in Winaero Tweaker lets you disable the 'Let's finish setting up your device' screen. This sometimes appears when you sign into Windows to push you into using OneDrive and other Microsoft tools.

3 You can create a desktop shortcut for an option you may need to disable or enable in future, to open Winaero Tweaker on that page. Either click the Actions menu and select 'Create desktop shortcut for this option' or press Ctrl-S.

4 If there are tweaks you're never likely to use, you can remove them from Winaero Tweaker's long list of options. Click the View menu, choose 'Select visible tweaks' and untick the boxes next to any unwanted settings and categories.

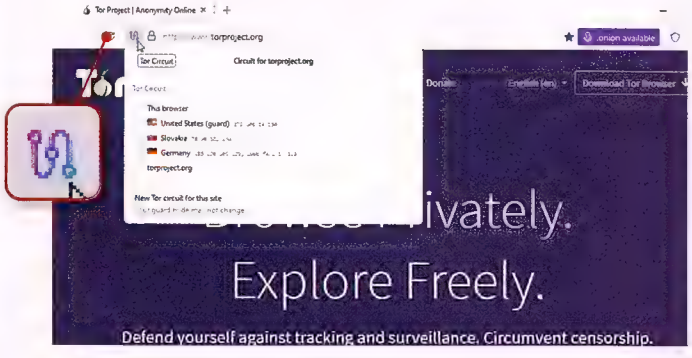


Windows 7, 8.1, 10 or 11 | tinyurl.com/APC524wise

WISE PROGRAM UNINSTALLER 3.14

Uninstaller

Wise Program Uninstaller is one of our favourite free tools for removing unwanted software from your PC, and this update makes some small but welcome improvements. Particularly useful is the new Last Run column on the home screen (see screenshot), which tells you the date you most recently used each program. This makes it easier to decide whether to keep a forgotten tool or uninstall it to free up space. Wise Program Uninstaller has also streamlined its Forced Uninstall function to speed up the removal process. Rather than backing up all a program's files before it moves them to the recycle bin, it now only backs up its registry entries – but note that you should only use Forced Uninstall when Safe Uninstall doesn't work. Additionally, you can now delete all your uninstall logs in one go – click the three-line Menu button, select Uninstall History and click 'Delete all'.

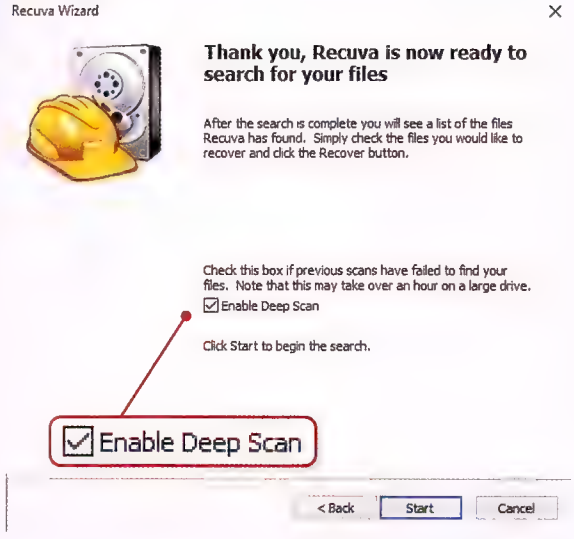


Windows 7, 8.1, 10 or 11, macOS or Linux | www.torproject.org

TOR BROWSER 12.5.

Private browser

Although it's not as fast or user-friendly as the new DuckDuckGo browser, Tor Browser is a highly effective way to access the web anonymously. The latest version updates the browser's 'circuits' feature, which routes your internet connection through a series of encrypted 'relays' to hide your IP address and online activities. Previously, you needed to click the padlock or onion icon (when visiting onion addresses) to view the circuit information for the current site. You can now click a dedicated Tor Circuit button to the left of the address bar (see screenshot) to see the three relays your connection has been sent through, including their locations and IP addresses. If you suspect your privacy has been compromised, click 'New Tor circuit for this site'. Tor has also added a connection- status indicator to confirm whether you're connected to its network.


Recuva Wizard
Thank you, Recuva is now ready to search for your files
After the search is complete you will see a list of the files Recuva has found. Simply check the files you would like to recover and click the Recover button.
Check this box if previous scans have failed to find your files. Note that this may take over an hour on a large drive.
Enable Deep Scan
Click Start to begin the search.
Enable Deep Scan
< Back
Start
Cancel

Should I pay for...?

Windows 7, 8.1, 10 or 11 | $39.95 | Free trial: None | www.ccleaner.com/recuva

RECUVA PROFESSIONAL

PDF converter

No file-recovery tool is guaranteed to restore your deleted data, but Recuva has a higher success rate than most. After being neglected by its developer (the Avast-owned Piriform) for several years, the program recently received some small updates, but is it worth paying for its Professional edition to get more features?

Unlike some free recovery tools, Recuva doesn't limit the number or size of files you can salvage. The paid-for version offers the same 'advanced file recovery' and 'Deep Scan' option (see screenshot) – it doesn't find or restore more items, so you don't get better results for your money.

Its main benefit is the ability to recover deleted files from virtual hard drives, such as those created in VirtualBox. This is undoubtedly useful if you regularly work with virtual machines, but that's unlikely to apply to most home PC users.

Recuva Professional also offers automatic updates, but as the program is now rarely updated, and even then only with "minor performance improvements and bug fixes", it's hardly an incentive to upgrade. Besides, you can update the free version manually by clicking 'Check for updates'.

The only other reason to pay for Recuva is for 'premium' technical support. However, we doubt you'll get much help from Piriform or Avast unless you're complaining about Recuva's disgraced stablemate CCleaner.

> "The paid-for version offers the same 'advanced file recovery' and 'Deep Scan' option – it doesn't find or restore more items, so you don't get better results for your money."

OUR VERDICT: Don't pay for it

Whereas CCleaner now limits its best features to its Pro edition, the free version of Recuva offers everything you need to recover lost files, and there are no real advantages to upgrading. We only wish its developer paid more attention to this much-loved tool.

TYPINATOR 9.0

Powerful text expander that speeds up repetitive documents.

■ $52 | ergonis.com | macOS 10.15 or later

We all know how tedious and time-consuming it can be when you repeatedly have to type certain pieces of text several times every day, such as your address or information about a new product. The macOS does have an option in the Keyboard settings panel that can help here, by allowing you to create text 'replacements'. These are short snippets of text that are automatically replaced by a longer piece of text when you're typing – such as typing 'myweb' and instantly expanding that to show your company's full web address.

That's a handy time saver, but this option in macOS is quite limited, and is really only suitable for simple, short pieces of text.

However, there's a category of apps – referred to as 'text expanders' – that can take this process even further. Typinator has long been one of the most popular text expanders, and has recently been updated to version 9.0. Version 8 was already able to run natively on Macs with Apple silicon, but version 9 deals with some additional compatibility issues to ensure that it is now fully compatible with Ventura. The program's interface has also been updated, opting for the rounded corners, pastel colours and cute icons used in Ventura.

On its simplest level, Typinator works in a similar fashion to text replacements in macOS. You start by typing a short piece of text – which Typinator calls an 'abbreviation' – into a small text box. Beneath this there's a larger window where you can type the full-length, expanded version of that text – so, again, the abbreviation 'myweb' could be expanded into your full web address. Typinator goes even further, though, as its abbreviations can also be used to insert graphics files, such as a company logo, or a picture of a new product. You can also insert HTML code or dynamic data, such as the current time or date, which can change all the time.

> "On its simplest level, Typinator works in a similar fashion to text replacements in macOS."

However, Typinator's greatest strength is its ability to use predefined 'sets' of abbreviations. Some sets simply focus on convenient time-saving abbreviations, such as expanding 'dt' to give you the date and time, while others can automatically switch between US or UK spellings for business documents. There are specialised sets for working with HTML, and you can also create your own custom sets of abbreviations and share them with colleagues at work.

It can take some time to master all these features – especially as Ergonis' 40-page manual isn't as clear or concise as it could be – and there are rival text-expander apps that are more affordable and easier to use. However, there's a trial version available, so you can experiment with Typinator first and see if it can speed up the creation of your business documents before buying the full version.

There are simpler text-expander apps, but Typinator's time-saving features will appeal to many.

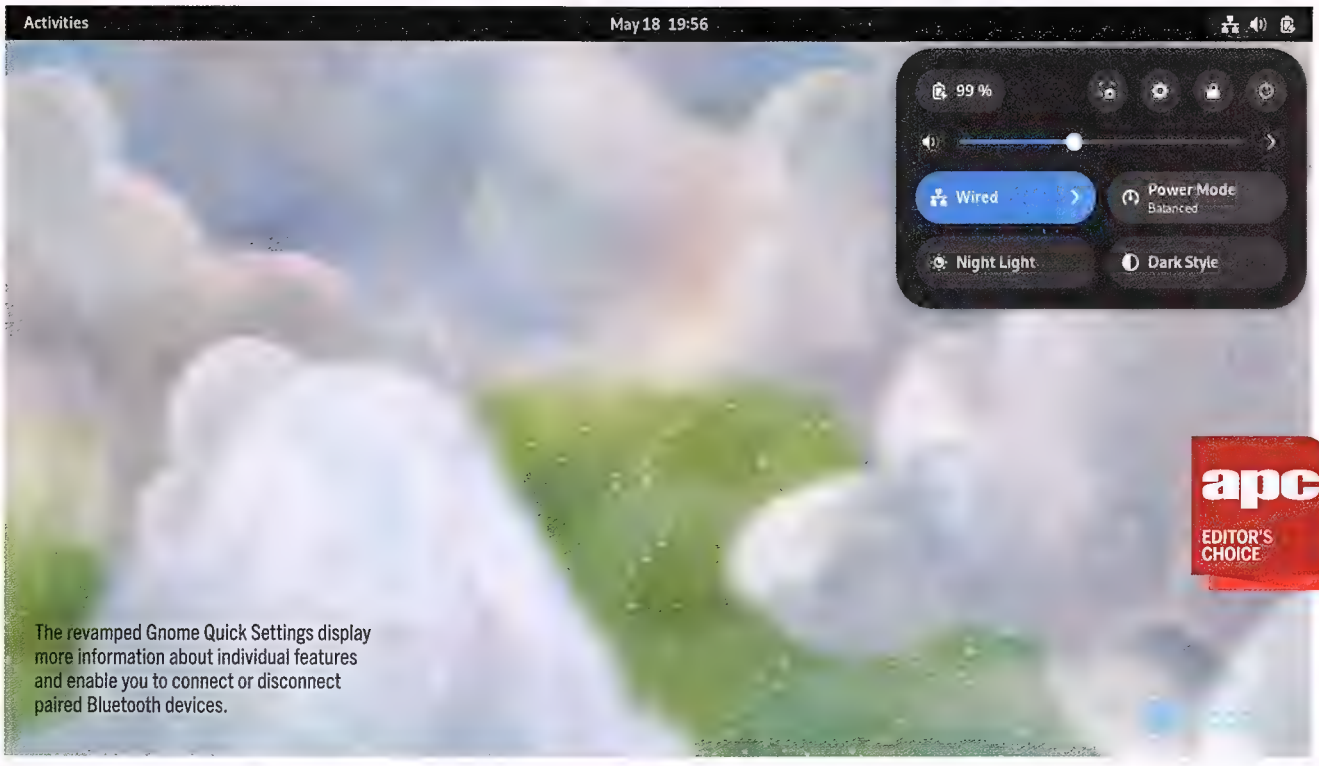
Cliff Joseph

★★★☆☆

FEDORA 38

Nate Drake took the latest Fedora for a test drive and was blown away by the vast array of new spins and features.

■ Licence GPL2 | fedoraproject.org



The revamped Gnome Quick Settings display more information about individual features and enable you to connect or disconnect paired Bluetooth devices.

apc EDITOR'S CHOICE

Apart from being the chosen hat of everyone's favourite adventurer, Indiana Jones, Fedora is the upstream source of the Red Hat Linux Project. This puts it on the bleeding edge of innovation when it comes to software packages, so we were eager to see if Fedora 38 lived up to its predecessors. This latest version was announced on the Fedora blog a week early, which came as rather a surprise to the Linux community, which is used to a more sedentary development cycle.

If you've already decided on the Workstation (desktop) version of Fedora, you're still spoiled for choice when it comes to desktop environments. Apart from the default Gnome (pictured), there's now an official spin of the Budgie, KDE, Xfce, LXDE, MATE and Cinnamon environments.

Once you've chosen, you can either download a special image writer tool to copy your chosen flavour to USB or just choose the ISO. We were pleased to see the Gnome flavour of Fedora 38 was a very trim 2GB.

Once you've had enough of test-piloting Fedora in live mode, you can fire up the Anaconda installer, which can automatically partition your drive and encrypt it.

On first boot, Fedora launches a setup guide that lets you choose whether to enable location services and error reporting. You can also choose to enable third-party repos to install proprietary software such as drivers, as well as an unfiltered view of apps on Flathub. Finally, you're asked to set a username and password.

This done, you'll find an impressive overhaul of the interface thanks to Gnome 44. The cloudy default wallpaper may not be to everyone's taste but there's a number of alternatives in Gnome's settings.

While we're on the subject, the new Gnome lock screen displays a blurred version of the desktop in the background. The Quick Settings menu has also been overhauled, now showing both the name of a setting with its status below, such as 'Power Mode – Balanced'. You can also view and close background apps here.

Although the Quick Settings menu has previously displayed Bluetooth, you can now more easily disconnect and reconnect to previously paired devices.

The file manager now also supports icon view and previewing of image files. You can also now navigate folders more easily via the list view (you need to enable this in the file manager Preferences if you want to use this feature).

Fedora 38 uses version 6.2 of the Linux kernel, which has hugely improved hardware support and bug fixes. Pre-installed apps include the latest versions of Firefox, LibreOffice and RhythmBox.

You can install more via Gnome Software. You may want to look into this on first install as Fedora still has no bundled email client.

The lightweight microdnf package manager has also now been replaced with dnf5, which has a radically smaller memory footprint. You can also still disable individual software repositories via Gnome's settings.

Fedora 38 has stricter rules about how long running services can block shutdown. In theory this should help devices running it to power off faster and efficiently.

The Fedora Project states the four main foundations of what it does as "Freedom, Friends, Features and First". It's precisely its friendship and sponsorship with Red Hat that allows it to include the latest innovations in its OS, with amazing features such as those in the new Gnome 44 desktop. We're also pleased to see its devotion to freedom in software now extends to giving users the choice of whether to use third-party repos and programs instead of filtering content for them.

Fedora has outdone itself again with a smooth setup and innovative features, not to mention all the available spins.

Nate Drake

★★★★☆

Home computers in Australia, a fast history

Part 3: *A new dawn. Commodore, Tandy and Apple all survived the 1983 crash largely intact. But the hard-won peace would soon be shattered, as acrimony found its way back onto the menu.*

***Darren Yates** writes.*

PART 4 OF 5
Don't miss next issue, subscribe on page 22!

By 1984, the home computer market looked like a comparative war-zone, with the wreckage of failed home computers strewn across the retail landscape and filling up $99 bargain bins. Yet, left standing were the 'original three' – Commodore with its C64 the dominant player; Tandy Electronics and its venerable TRS-80 range; and Apple with its Apple II series and the soon-to-arrive Macintosh. However, those heady days of 1977 were long gone, with consumers disappointed by poor-quality games and a lack of compatibility – and for one of these pioneers, things were about to boil over.

Above: The C116 was a lower-cost Commodore Plus/4 with cheaper keyboard and no built-in software (Image credit: Thomas Conte, CC BY-SA 2.0).

Commodore 2.0?

As we saw last time, the battle between Commodore and Texas Instruments for home computing supremacy had been especially brutal, with the latter unable to sustain the losses of pitting its TI-99/4A up against an ever-cheaper Commodore VIC-20 and bailing from the market in late-1983.

But any thought Commodore executives may have had of the New Year bringing the company 'clear skies' were dashed in spectacular fashion barely two weeks into 1984, with the acrimonious departure of founder Jack Tramiel. The reason for Tramiel's fiery exit is generally put down to a clash between himself and Irving Gould, the Canadian businessman who had kept the company afloat on more than one occasion and effectively held the reins at Commodore for most of two decades.

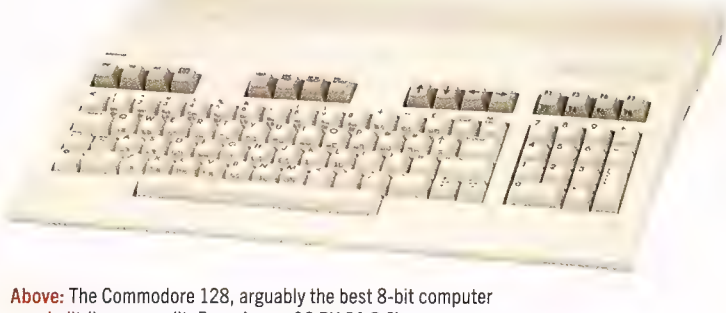
Each side tells the story differently and we don't have space for it here, but the end result was the same – Tramiel had exited the building, leaving Commodore with quite the gap to fill.

Nevertheless, Tramiel wasn't going to quietly sail off into the sunset. On the contrary – by the end of 1984, Tramiel had set up his own tech company ('Tramel Technology'), purchased former-competitor Atari from its Warner Communications parent and rebranded it 'Atari Corporation'. But if that wasn't enough, he also had ready a new 16/32-bit computer, the Atari 520ST, to spruik at the fast-approaching 1985 Consumer Electronics Show in Las Vegas.

Regardless of who was to blame for Tramiel's exit, it was a stunning turn-of-events in such a short space of time. Now, Commodore, the company Tramiel had started from scratch, was in his sights.

Meanwhile, Commodore had already been working on a C64-followup, since dubbed the '264' series. The first model was the Commodore 116, launched in June 1984, but it didn't make it to Australia in significant numbers. Given its chiclet keyboard and a rumoured price point of as low as US$49, it's possible Commodore's Australian office skipped right passed it on the order-sheet. However, the two models that did arrive here in number were the C16 and the Plus/4.

Above: The Dick Smith VZ200 computer made the cover of our April 1983 issue.



Above: The Commodore 128, arguably the best 8-bit computer ever built (Image credit: Evan-Amos, CC BY-SA 3.0).

Commodore 16, Plus/4 (1984)

While the C16 featured 16KB of RAM and followed the similar 'bread-bin' styling of the VIC-20 and first-gen C64, the Plus/4 had a more angular, industrial design. Rather than replace the C64 however, Commodore aimed the Plus/4 at the home business market, thanks to its built-in business software. In addition to 64KB of RAM and enhanced Commodore BASIC 3.5, the Plus/4 delivered four business apps built into on-board ROMs and activated by function keys at the top of the keyboard. These were word-processor, spreadsheet, database and a graphing app. They were also interconnected enough that you could move data from one app to another.

We had one of these at home at about the same time as the Dick Smith CAT, but I found the software pretty disappointing – for example, the word processor could handle 80-column text, but had to scroll off-screen to do so, as it only displayed 40-column text. The Australian version ran a MOS Technology 7501 CPU at 1.77MHz (although code mostly ran at half that rate) and to improve the video quality, a composite-video output was additionally provided.

The 7501 was a variant of the 6510 CPU that powered the C64, but sadly, Commodore dropped its famed VIC-II video and SID sound chips here for a MOS 7360 combined video/sound chip. The real problem for home users wanting an updated C64 was the Plus/4's lack of hardware sprites – that made the Plus/4 incompatible with most graphics-based C64 games. As the C16 was built on the same platform as the Plus/4, it didn't have hardware sprites either. On the up-side, however, it did support a disk drive, but while the Datasette (data cassette storage) looked identical to the C64 version (apart from colour), a different cable connection made the two models incompatible.

Aside from the lack of sprites, the Plus/4 and C16 machines were better architecturally than the Commodore 64 in some respects. For example, Commodore BASIC 3.5 was a notable improvement over the v2.0 inside the C64 (more fun to code with better loop control).

Nevertheless, neither the C16 nor Plus/4 sold in huge numbers in Australia, although around one-million C16, C116 and Plus/4 computers were reportedly sold globally. Local retailer Grace Bros (now Myer) sold the Commodore 16 for $289 in 1985, but the 264 series was discontinued later that year, with the Plus/4 another to sell here for $99.

Amstrad CPC464 (1984), CPC664, CPC6128 (1985)

Meanwhile, the eponymously-named Alan Michael Sugar Trading – better known as 'Amstrad' – was a mid-level UK electronics brand that largely sold affordable TV/Hi-Fi-audio gear during the 1970s. However, as the Hi-Fi market began to fade during the early-1980s, Sugar was eager to pivot to home computing and in 1983, the company began developing its first home computer.

That computer became the Amstrad CPC464. Arriving onto the market in mid-1984, the stylish design featured a built-in cassette recorder for storage and cleverly included arrow keys and numeric keypad. The CPC664 arrived the following year, replacing the cassette recorder with a 3.5-inch floppy disk, but it was short-lived, itself replaced by the 128KB-RAMed CPC6128 in late-1985.

Despite its late arrival onto the market, the timing of Amstrad's run was actually quite fortuitous. Not only had Amstrad sidestepped the calamity of the previous year's carnage, but 1984 was a comparatively-slow year for new releases. Tandy's only launch-of-note for 1984 was the excellent Tandy 1000 IBM PC-compatible late in November, Apple's new Macintosh was well beyond most

Above left: The Commodore 16 replaced the VIC-20, but wasn't compatible with the latter's software (Image credit: CBmeeks, CC BY-SA 3.0).
Above: The TRS-80 Color Computer 1 featured a calculator-style keyboard and 16KB of RAM when released in 1980 (Image credit: Bilby, CC BY 3.0).

Below: The 1986 TRS-80 CoCo 3 offered 128KB of RAM, but the same 6809E CPU (Public Domain).

Above: The Commodore 128D came with a separate keyboard and built-in floppy disk drive (Image credit: Rama, CC BY-SA 2.0 fr).
Above right: The Commodore Plus/4 was aimed at business users with built-in software (Image credit: Thorsten Kuphaldt/ Foofy, CC BY-SA 3.0).

budgets (the original Macintosh 128K sold in Australia for around $4,000) and Commodore's management argy-bargy left it with the largely-underwhelming 264-series.

What's more, the CPCs were decent machines, too, with their Zilog Z80 CPU hitting 4MHz and a top resolution of 640x200-pixels in two-colour mode giving 80-column text.

AWA (Amalgamated Wireless Australasia) distributed the CPC range in Australia until Amstrad opened a local subsidiary in 1988, with the CPC6128 selling for about $1,000, with colour monitor.

Commodore 128 (1985)

There's little doubt 1984 was shaping up as an annus horribilus for Commodore. With Tramiel gone and the '264' series failing to live up to expectations, the company had begun looking to the future with the purchase of Amiga Corporation mid-year (another fascinating story). However, the next-gen computer that would become the Commodore Amiga 1000 wouldn't be ready for another year.

Meanwhile, the Commodore Plus/4 had been designed in late-1983 by Bill Herd, a 24-year old self-taught electronics engineer and despite the comparative lack of success for the '264' series, Commodore was looking to send out the 8-bit era with one last machine and Herd was given the opportunity to design it. There was just one catch – he had to bring it together, design and production, in just five months, ready for the January 1985 Consumer Electronics Show in Las Vegas. Almost miraculously, he and his team met the deadline and the computer they created was arguably the best 8-bit home computer of all time – the Commodore 128.

The C128 was not only the first home computer with 128KB of RAM, it packed two CPUs– the new MOS 8502 plus a Zilog Z80 (the first 'dual-core' home computer). This gave the C128 three operating modes – its native 80-column C128 mode, a C64-mode with almost full-compatibility, plus a CP/M mode to access popular CP/M-based business software via the Z80 CPU. It also featured Commodore BASIC 7.0, which left for dead the comparatively-primitive BASIC 2.0 of the C64. In effect, you needed an IBM-compatible to come close to this capability at the time.

However, an event the following year would overshadow the C128 and even the 16-bit Amiga and Atari ST computers to follow. In 1986, Compaq released the first 32-bit Intel 80386 IBM-compatible desktop computer, the Deskpro 386. It marked the first time a new Intel-powered 'IBM PC' didn't come from IBM and consumers began realising how powerful the term 'IBM-compatible' really was.

Below: Although late to the home computer party, Amstrad's CPC464 was a decent effort (Image credit: Bill Bertram, CC BY-SA 2.5).

TRS-80 Color Computer III (1986)

By this time, Tandy Electronics had also jumped onto the IBM PC bandwagon, with the Tandy 1000 still considered one of the best PCs of the era. In fact, its success so worried Color Computer ('CoCo') fans, many feared their 1983-vintage TRS-80 Color Computer 2 models were set to be abandoned by Tandy – along with the TRS-80 brand – for good.

However, users got their wish, with Tandy releasing one last piece of 8-bit home-computer history in the TRS-80 Color Computer 3. While the CPU remained unchanged from the original CoCo's Motorola 6809E running at 0.895MHz, it had something of a software-controlled 'turbo' mode that doubled the clock rate to 1.79MHz. Tandy had also upped the RAM from a peak of 64KB with the CoCo 2, to 128KB default on the new CoCo 3 and expandable to 512KB.

Improvements to video output

also appeared, with a composite-video out from a new 'Graphics Interrupt Memory Enhancement' chip. The keyboard also received a face-lift with arrow keys positioned in a diamond pattern. It appeared in Tandy Electronics' Australian catalogue as a 'New for 87' computer priced at $450, with a CGA (640x200-pixel) 'high resolution' monitor selling for $700.

The end of an era

The story of computing obviously continues but 1986 really marked the end of the 8-bit era. Commodore would continue to produce the C64, but the focus was now on its Amiga series, as it did battle with ex-boss Tramiel's new Atari ST range. However, neither company would see out the 1990s – Commodore filed for bankruptcy in 1994 and Atari was effectively gone in 1996.

As for Tandy, the company was caught between its TRS-80 computers and its burgeoning PC business. The TRS-80 CoCo 3 was Tandy's last 8-bit hurrah, with production ending in 1991.

Keeping the flame alive

No doubt, some may bristle at suggestions the 8-bit era is over – since for many, it still lives on.

Today, key 8-bit milestones like the Commodore 64, Tandy TRS-80 and even the Dick Smith VZ200 are collectors' items, but due to their age (now pushing 40 years old), they generally require care to maintain in working order (and often attract a sizeable price premium). Yet, a number of those classic machines have been re-issued in recent times, such as THEC64, a C64 re-issue combining the original Commodore BASIC and game ROMs with new-generation ARM Cortex CPUs. There's also an array of community efforts, such as the up-coming 6502-powered Commander X16 by David Murray ('The 8-bit Guy') worth keeping an eye on, not to mention the MaxiMite releases by Geoff Graham.

Meanwhile, many of those systems we've covered are available as online or PC emulators – even the Mattel Aquarius. So if you can't experience the real thing, you can still try your hand at 8-bit gaming, or better still, some 8-bit coding on your PC.

Fun-fact: we tested the Dick Smith VZ200 in our April 1983 issue, calling it 'a great little machine and one that is likely to change the face of Australian personal computing'. That's a pretty decent rap!

But... why so golden?

In some ways, it's difficult to nail down exactly what made the home computer era such a golden one, but I reckon it came down to a couple of things. First, having a computer at home was a revelation and a revolution, akin to your first mobile phone or games console – you started to wonder how you ever lived without it. But second, it was a time when computing was fun – no-one had heard of 'cyber-security', you just chose your brand and stuck with it like a football team.

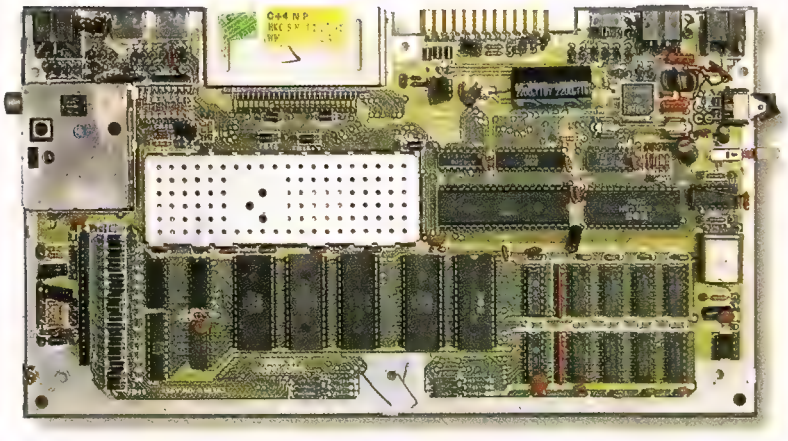
Frankly, I do blame IBM for ruining it for everyone – one of the great joys of being at school in the 1980s was knowing when a hot new game was released for your computer, but not your mate's. Yet, IBM with its off-the-shelf compatibility destroyed that playground cred – now, as long as you had an 'IBM-compatible', it just worked and you had to actually earn any cred by proving your gameplay.

But seriously, the era between 1974 and 1986 was a golden age for technology in Australia. During that period, we saw the arrival of home computers, colour television, the Walkman, the video cassette recorder and the compact disc. Each one was a revolution in its own right, but all five together made for a golden era of tech we're unlikely to ever see again. And what an era it was.

Epilogue

There is still one more chapter in this 8-bit story to tell that doesn't quite fit here, but it's fascinating nonetheless (and no, it's not Arduino). Next time, we trace the history of a very special group of 8-bit computers that long outlived the big 'alpha' brands right into the current century. See you then. ■

Above: Less than a year after the CPC464, Amstrad launched the CPC6128 with built-in floppy drive (Public Domain)



Above: The Compaq Deskpro 386 was the first Intel 80386 IBM-compatible PC (Image credit: MBlairMartin, CC BY-SA 4.0).
Left: The Commodore Plus/4 was a heavily-populated single-board computer (Public Domain).

VISION ON!

THE PAST, PRESENT AND FUTURE OF SPATIAL COMPUTING

Is Vision Pro the future market leader, or just an overpriced gimmick? Ian Osborne takes a look at the history and future of virtual and augmented reality, and speculate on where Apple's new device might take us.

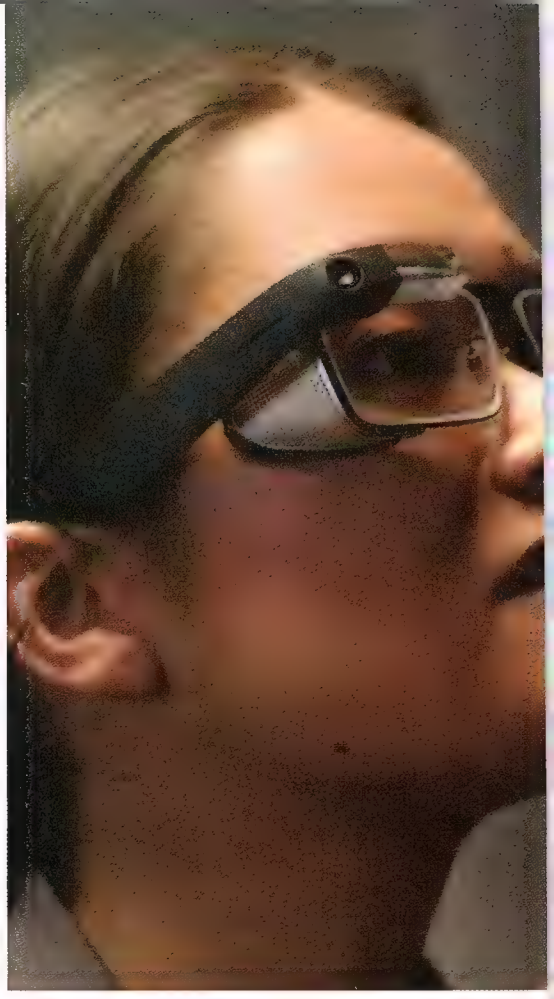
Virtual and augmented reality have been sci-fi staples for years. Virtual reality (VR) puts you in an alternate world, where you can look, move and interact as if you were really there (think of the holodeck in *Star Trek*. Augmented reality (AR) overlays computer-generated graphics and information over the real world, so you see both through your glasses or on your screen (like in *Pokémon Go*). Both of these concepts have a longer history than you realise. And then there's mixed reality (MR), which delivers the best of both.

Over the last few years, the technology behind these concepts has matured to the point where it promise to change the way we use our devices. We're promised immersive games, with the player at the centre of the action. Video chats could be transformed, with the participants sitting around a virtual table in a virtual office, probably drinking virtual coffee. Your augmented reality glasses could be used to find directions, which could then be superimposed on the street as you walk or drive. And if promoters replaced a seat at a concert or sporting event with a 360° HD camera, they could sell that seat hundreds of times over.

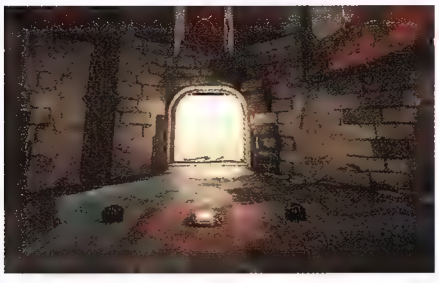
Here we look at the past, present and future of virtual and augmented reality. Where it came from, where it's going and how Apple fits into this space.

THE PAST

VR and AR have been around for longer than you think.



The roots of virtual reality can be traced back to 3D games and software where the environment is viewed from a first-person perspective. And these didn't start with *Doom* either. Which was the first such title is disputed; it's either space shooter *Spasim* or the blaster *Maze War*, both of which were released around 1974. They weren't actually virtual reality, of course. The gamer played them on a computer screen, just like any other game. But it's here one of its key features was established; the environment was viewed through the player's eyes, instead of their being represented as an on-screen avatar (known as 'own-eye perspective'). Later first-person games included the ZX81's *3D Monster Maze*, *Wolfstein 3D* and, of course, *Doom*.



First-person games like *Unreal Tournament* let you look around in 360° by using a mouse or joystick to move your in-game head.

From these basic first-person video games, the first-person shooter genre eventually took shape. When computers and consoles grew powerful enough, as well as moving through a virtual 3D environment, you could also look around in a 360° space by moving your in-game head. You could now look up and down, not just left and right.

Headsets with motion tracking had been worked on since the 1960s, mostly by the military for training and viewing dangerous situations. Myron W Krueger's VIDEOPLACE appeared in 1975, and is generally regarded as the first interactive VR system. It didn't feature a helmet, but its cameras and screens could measure the position of the user and react accordingly. The VITAL helmet, developed as a pilot training tool by McDonnell Douglas, included a head tracker. Also of note is Ivan Sutherland's Sword of Damocles, a head-mounted display which hung from the ceiling and added computer-generation graphics to the user's perception of the world.

The term 'virtual reality' was coined in 1987 by Jaron Lanier. His company, VPL, went on to release the Dataglove and the EyePhone head-mounted display. They're milestones in the history of VR, but too expensive to become mainstream. The term 'augmented reality' came from researchers Thomas Caudell and David Mizell, who used it for a head-mounted

The Legend Quest VR system

When the Legend Quest virtual reality arcade opened in 1992, there was nothing else like it.

Four gamers played together using VR headsets, with motion tracking and hand controllers to look after movement and actions. The player stood inside a circular barrier while playing, to make sure they didn't trip over anything in the real world while they explored the virtual one. The hardware used was based on seven enhanced Amiga 3000 computers. It could move 30,000 flat-shaded polygons at 20 frames per second with a maximum of 250 objects, though it slowed when there was too much happening on the screen. The helmet, which contained motion-tracking technology to see which way you were facing, covered the eyes with a small viewing screen in front of each eyeball. A speaker over each ear carried the sound effects, creating the impression of which direction a sound came from. It was true VR, albeit primitive by today's standards.

In *Dactyl Nightmare*, you had to shoot rival gamers with your virtual pistol. If you were hit, you respawned: the player with the most kills wins.

Much was expected from Google Glass, the augmented reality smart spectacles, but they never caught on. They were expensive, and lacked a killer feature.

display for aircraft construction at Boeing.

At the start of 1992, a virtual reality arcade featuring two VR games opened in Nottingham. *Legend Quest* saw four players at a time compete in the sci-fi themed *Dactyl Nightmare*, a death-match where you blasted other players while being stalked by killer birds. There was also an RPG also called *Legend Quest*, where you played a barbarian, a wizard, a thief or an elf. It gained a decent cult following, but it wasn't as widely franchised as had been hoped.

Home VR got off to a slow start. The Sega VR headset for the Sega Mega Drive/Genesis console was announced at the 1993 Consumer Electronics show, but never released. Ten years later a Kickstarter was launched which eventually led to the popular Oculus Rift, which was soon bought by Facebook. The Oculus Quest 2 is currently the best-selling VR headset of all time.

Google Glass proved much less popular. First sold as a prototype in 2013,

Following on from virtual reality arcades, home VR got off to a slow start

The most popular virtual reality system for home consoles is Sony's PlayStation VR.

it was underpowered and cost $1,500, which proved too much to allow it to find its niche in the nascent home spatial computing field.

Home VR gaming is still being fought over. As well as the aforementioned Oculus headsets (now known as Meta), Sony's PlayStation VR has sold over five million units, the Valve Index is great for VR games on Steam and there's HTC Vive and Samsung Gear VR to choose from too. Microsoft's HoloLens has been promised for years but, as of yet, it can only bought as a developer unit. A public release has yet to happen.

And if you're on a budget, there's always the unpowered VR goggles that house your smartphone and are used to watch online VR videos. Some people love them, but they can be very unkind to those who wear glasses.

VIRTUAL REALITY: THE PICK OF THE CURRENT CROP

Vision Pro faces some stiff competition from the leading virtual reality options already available. PlayStation VR, for example, is relatively affordable, runs quality, ambitious games and is comfortable to wear. The HTC Vive Pro 2 is more expensive, needs a decent-specced PC and can look a little foggy at times, but its hardware is very comfortable to wear and overall picture clarity is good.

The Valve Index is another VR system that needs a PC; it still doesn't support macOS. It's prohibitively expensive too, costing $2,900 even without the PC. But if you're serious about virtual reality, it has excellent picture quality, a superb 130° field of vision and some of the best controllers available on a home VR system. The very affordable Samsung Gear VR was once a no-brainer if you have a Samsung Galaxy smartphone, but the device is steadily being discontinued and doesn't support devices that update to Android 12.

Our favourite current VR system is the Meta Quest 2 (formerly Oculus Quest 2). It's very well priced, requires no other hardware and gives an incredibly immersive experience. Look out for Meta Quest 3 in the Spring too.

We reckon Meta Quest 2 is the ideal VR system, combining high quality with a great software support and a relatively low price.

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Tim Cook shows off Apple's new Vision Pro at the Worldwide Developers Conference 2023.

THE PRESENT

What's unique about Vision Pro, and what does it offer?

Apple has long been interested in what it's now calling spatial computing. As early as October 2020, the company introduced a LiDAR scanner in the iPhone 12 Pro. It stands for Light Detection and Ranging, and is a remote sensing method that uses a pulsed laser to measure the distance between the device and surrounding objects. This gives an excellent 3D impression of the room. It's great for augmented reality features, like trying out new furniture by superimposing its graphic onto the room before buying.

For third-party developers, Apple released ARKit, offering augmented reality frameworks and tools for them to use. There's some great augmented reality apps and games on Apple's App Store. Check them out at bit.ly/3Xn7tMo.

After years of development, this technology comes into its own with the Vision Pro. These VR/AR goggles 'seamlessly blend digital content with your physical space'. Announced at WWDC23 in June and due for release early next year, Apple's first spatial computer gives you an interface superimposed on the real world which is controlled with your eyes, hands, and voice.

Its operating system is visionOS, which has a Home screen that resembles iOS and macOS-like windows with which you interact. Vision Pro's ultra-high-resolution display system packs in 23 million pixels, and it runs on an Apple silicon dual-chip system. An M2 chip takes care of the processing needs, while a new R1 chip handles input from the device's 12 cameras, five sensors, and six microphones.

You can watch movies on the new device for a real cinema-like experience. Streaming apps seem likely. Apple TV+ is a no-brainer, we're already promised Disney+, Netflix seems inevitable and providers of TV streaming and catch-up services are sure to release their own apps. Naturally, gaming on such a large virtual screen would also be great fun.

As you'd expect from Apple, a lot of attention to detail has been taken with the interface. It's sensitive to light, adapting to ambient conditions and in-room decor, so the windows and menus become part of the room. They

The visionOS interface is clearly inspired by iOS and iPadOS.

The visionOS interface

VisionOS is instantly familiar to anyone who's used an iPhone or an iPad. Apps are presented as icons, but you open and close them with hand gestures and voice commands instead of tapping a screen.

Some of the apps will also be familiar to existing Apple fans, as will their functions and features. The Photos app, for example, syncs with your iCloud data and shows your pictures and videos, crystal clear and imposed on your physical space. You're no longer limited by the size of your screen. You can make your apps any size you want.

THE VISION PRO HARDWARE

1 Displays
Two microOLED displays each deliver more pixels than a 4K TV, and a Light Seal keeps out ambient light.

2 Controls
The device's controls are clearly inspired by Apple Watch. There's a Digital Crown and a pill-shaped button.

3 Spatial Audio
The speakers are positioned close to your ears, and deliver 3D audio that blends with real-world sounds.

4 Battery
The external battery, connected to the headset with a cable, provides around two hours of use.

5 Head Band
The Head Band is breathable and stretchable for comfort. A Fit Dial is used to make sure it's snug.

even cast virtual shadows, offering a sense of scale and distance. You can move apps around the room, placing them anywhere you want, and expand or reduce their size by dragging corner handles.

You don't have to use your own room as a backdrop either. Apple's Environments are scenes from around the world which you can use as the equivalent of an iOS/iPadOS wallpaper or a macOS Desktop image. You can even use a blend of the two, turning the device's Digital Crown to set how immersed you are.

As well as bringing existing technologies on board, Vision Pro is packed with new innovations. Take EyeSight... As Vision Pro augments your environment rather than taking you out of it completely, while using the device your eyes are shown through the Vision Pro. Those around you know you can see them and that they can interact with you. If you choose to immerse yourself in the virtual environment, so you can't see those around you, your eyes are replaced by a coloured pattern so others know you can't see them.

In another outstanding innovation, Vision Pro is Apple's first ever 3D camera. You can take pictures and videos in 3D, and relive those memories as never before. It's amazing what we might be able to achieve with Apple's first spatial computer.

FaceTime with Vision Pro

As with most recent Apple products, communication is at the heart of Vision Pro. FaceTime calls are catered for, with each participant in the video conversation appearing in a different tile. You can scale and position the tiles however you please, and to make conversation more natural, the device's Spatial Audio features make it appear that each person's voice is coming from the location of their tile.

You can use your Vision Pro to create a very realistic digital avatar of yourself. This enables others to see your face while you're wearing Vision Pro in a video chat, dynamically following your head and hand movements.

It's the next best thing to being in the same room.

© Apple Inc

THE FUTURE

Where next for spatial computing and Vision Pro? We look at what to expect.

The technology behind Vision Pro looks great, but as Apple is well aware, tech is a means to an end not an end in itself. What will the company's first spatial computer be used for? How will it find its place in the modern home and office?

With apps like Safari, Keynote, Calendar, Messages, Notes, Freeform, the Microsoft Office suite and more, Vision Pro could be a real boon for work, and not just for remote video meetings. You can, for example, use the Messages app to send 3D images as well as regular missives, pulling them out of the app and exploring them in your own space. This is great for industrial designers, architects and engineers, for example, and others who might need to share prototypes.

When you're watching the room as well as your content, your eyes are shown on the goggles.

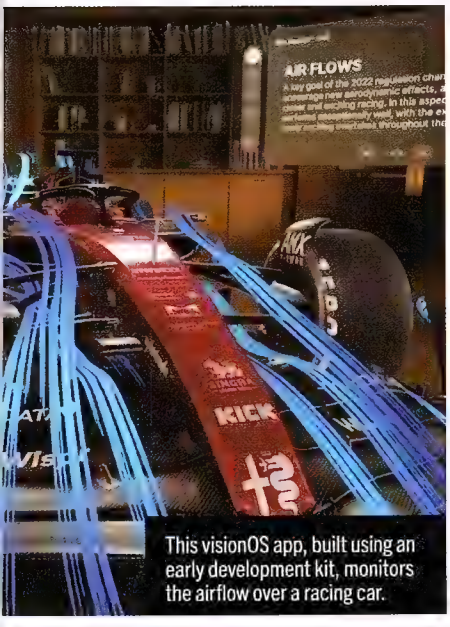
It could prove great for entertainment too. As we've already said, it gives a real immersive experience when watching TV shows or movies (including 3D movies), and as the Music app is included in visionOS, you can enjoy your favourite tunes too.

On launch we're promised over 100 Apple Arcade titles that can be played with Vision Pro, which offers full controller support, and games that make full use of its augmented and virtual reality capabilities will surely follow.

But will Vision Pro last long enough to achieve its goals? Two main challenges stand between the Vision Pro and the sort of mass adoption it needs to succeed: price and battery life.

When Vision Pro is released early next year (or so we're promised – there may be delays), it will cost US$3,499, making the likely Australian price something north of $5,000. That's more than most Mac laptops. Even if it's worth the price, people won't spend that much – especially on a new and untested piece of hardware – without careful consideration. Potential purchasers might well hesitate, watching the Vision Pro scene develop and mature before joining it. If initial sales are slow, developers and content providers might do the same, reluctant to invest resources on a platform with a limited user base.

This could create a vicious circle where the public and the industry alike adopt a



This visionOS app, built using an early development kit, monitors the airflow over a racing car.

App developers get on board

Although visionOS is a completely new platform, its frameworks and tools are already familiar to app developers. So despite being new, it shouldn't be a major challenge to program visionOS apps.

visionOS apps can include one or more windows, which are built with Apple's SwiftUI framework. As well as traditional controls, developers add depth with 3D content. Apple's 3D rendering engine, RealityKit, is used for 3D content, animations, and visual effects. ARKit understands your surroundings and powers core system capabilities that apps automatically benefit from when they're in the Shared Space. Games programmers can use Unity, which has access to the benefits of visionOS, making titles created on the platform look at home. This low entry bar should work in Apple's favour, lowering the commitment required – and therefore the cost – of developing apps and games for the platform. Even so, making the best use of Vision Pro's tech will still take time, effort and (most importantly) money. We expect early software releases will be 'shovelware', that is, created for other Apple platforms and tweaked for visionOS.

'wait and see' attitude, with developers waiting for more sales before getting on board and users waiting for more content before buying, preventing Vision Pro from achieving the early market penetration it needs to truly become a success.

The other major challenge is battery life. Putting the power supply in an external unit you can keep in your pocket was a good move; much better than housing such a heavy component in the headset. But it lasts just two hours. Two hours! That's not enough to watch a lot of movies. You can connect to the mains, of course, but then you're tethered to a single spot, without the freedom advertised in Apple's WWDC keynote.

Doubtless when Vision Pro is released spare batteries will be on sale in the Apple Store, with third-party devices to follow. And hopefully, you can unplug the spent one and connect a new cell without turning off the headset. Even so, battery life is something Apple will have to address going forwards.

You can send and receive 3D objects using Vision Pro, and look at them from every angle.

It's been a long time coming but there can be no doubt that Vision Pro is a really exciting piece of kit. Sure, we've seen augmented and virtual reality systems before, but is this the first device to get it right? Only time will tell.

A Vision Lite?

One of the ways Apple increased the iPhone's market penetration was to release a lower-cost device for entry-level users: the iPhone SE. Could the company take a similar approach with the Vision Pro?

Being such a new device in an emerging market (unlike the iPhone, which was preceded by many other mobile phones), we would expect the Vision Lite (or whatever Apple calls it) to arrive early in the product's life cycle; maybe as early as a year after the release of Vision Pro.

Where Apple would make the savings required to keep the retail price down is a puzzle, but maybe a year's worth of Vision Pro production would pave the way for a lower cost device with fewer components. Perhaps a new Apple silicon chip could integrate the M2 and R1 chipsets, for example, in a lower-priced but less powerful alternative?

While no VR system is cheap enough to be a casual purchase, devices like the Meta Quest 2 come in at less than $600, which is affordable enough to satisfy even if you only use it occasionally. Thus, it can attract casual users as well as hardcore enthusiasts. We doubt a Vision Lite could ever reach this price point, but it needs to be no more expensive than circa $1,500.

Spatial awareness: What Apple says. . .

"[Vision Pro] marks the beginning of a journey that will bring a new dimension to powerful personal technology"

Tim Cook, CEO, Apple

"Vision Pro lets developers reimagine existing apps and create brand new ones"

Susan Prescott, VP, Worldwide Developer Relations

"Apple Vision Pro allows us the freedom to imagine and experience unlike anything we've created before"

Alan Dye, VP, Human Interface

› Image credit: Apple Inc

MSI
1905 MHz
7000 MHz
0 V
68 °C
VOLTAGE
CLOCK
FAN
CINEBENCH R23
MAXON
HWiNFO64 v7.50-5150
Program Report Monitoring Help
Summary Save Report Sensors About
NICK-PC
Central Processor(s)
AMD Ryzen 7 5700X
Motherboard
ACPI Devices
SMBIOS DMI
Memory
Bus
PCI Bus #0
Video Adapter
NVIDIA GeForce GTX 1
Monitor
Drives
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Samsung SSD 970
KINGSTON SA2000
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Network
Ports
Feature
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NVMe (PCIe 4x 8.0 GT/s)
Host Controller:
Samsung NVMe PCIe SSD Controller
Drive Model:
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7 nm
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TDP
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Vermeer
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OPN
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CPU #0
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AM4
Cores
8 / 16
Cache L1
8x32 + 8x32
L2
8x512
L3
32M
L4
Features
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SSE
SSE-2
SSE-3
SSSE-3
SSE4A
SSE4.1
SSE4.2
AVX
AVX2
BMI2
ABM
FMA
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SMAP
EM64T
HTT
CPB
AES-NI
RDRAND
RDSEED
SHA
SME
Operating Point
Clock
Ratio
Bus
VID
Minimum Clock
550.0 MHz
x5.50
100.0 MHz
Base Clock
3400.0 MHz
x34.00
100.0 MHz
Boost Max
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100.0 MHz
PBO Max
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x0.96
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Chipset
AMD X470 (Low-Power Promontory PROM28.A)
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07/25/2022
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Clock CL RCD RP RAS RC Ext. V
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1067 15 15 15 35 49 XMP 1.20
933.3 13 13 13 30 43 XMP 1.20
800.0 11 11 11 26 37 XMP 1.20
666.7 9 9 9 22 31 XMP 1.20
533.3 8 8 8 18 25 XMP 1.20
1200 16 16 16 39 55 - 1.20
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933.3 13 13 13 30 43 - 1.20
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GPU
MSI GTX 1660 Super Ventus XS OC
NVIDIA GeForce GTX 1660 Super
TU116-300
PCIe v3.0 x16 (8.0 GT/s) @ x16 (2.5 GT/s)
GPU #0
6 GB
GDDR6 SDRAM
192-bit
ROPs / TMUs
48 / 88
Shaders
Unified: 1408
Current Clocks (MHz)
GPU
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Memory
101.3
Video
540.0
Operating System
UEFI Boot
Secure Boot
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HVCI
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Drives
Interface
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NVMe 4x 8.0
NVMe 4x 8.0
ATAPI
NICK-PC -> Drives -> NVMe Drives ->
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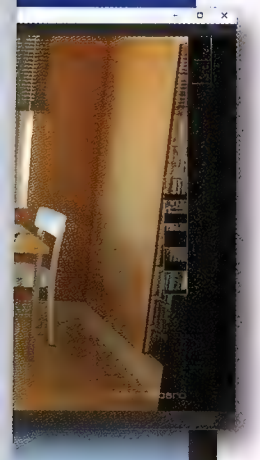
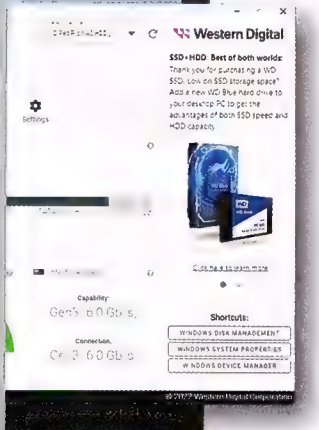




KEEP YOUR MACHINE IN TIP TOP SHAPE

PC SERVICE & TUNE-UP GUIDE

PERFORMANCE TUNING * THE APPS YOU NEED & HOW TO USE THEM * AUDIT YOUR SYSTEM AND NETWORK RESTORE SYSTEM SPEED

ENSURE YOUR PC REMAINS IN TIP-TOP SHAPE AND FIGHTING CONDITION WITH THE HELP OF NICK PEERS.

All mechanical products require maintenance to keep them running. You get your truck or car serviced at regular intervals to ensure that failing parts are spotted and replaced, while tuning the engine to improve performance and efficiency, so why not your PC too?

In this feature, we've developed a simple program to help you ensure that your PC's hardware is running as well as it possibly can. We'll start by showing you how to audit your system so you can identify everything that's in it, from the stuff you should already know about (like your graphics card model or CPU), to more obscure components (what USB controllers is your motherboard using, for instance?).

From there, we'll put in place tools that can help you monitor your system, providing you with early warnings for the parts that may be on their way out, from ageing hard drives to batteries in a state of decline. You'll learn how to identify other potential problems through stress-testing, before we switch our attention to examining ways to tune your hardware for better performance, from basic updates to judicious overclocking of selected components.

Ready to put your PC through its paces? Let's get started.

The first step to maintaining your PC is to perform a complete hardware audit. This provides you with a detailed inventory of the various components that make up your PC – ncluding the chipsets that populate your motherboard, allowing you to monitor key aspects of them.

Our current tool of choice is HWiNFO (**www.hwinfo.com**), which is free for personal use, and can be installed or deployed as a portable app. After setting it up, launch HWiNFO and give it administrator access when prompted. You'll be prompted to start the app, which comprises three main windows: Main, Summary, and Sensors.

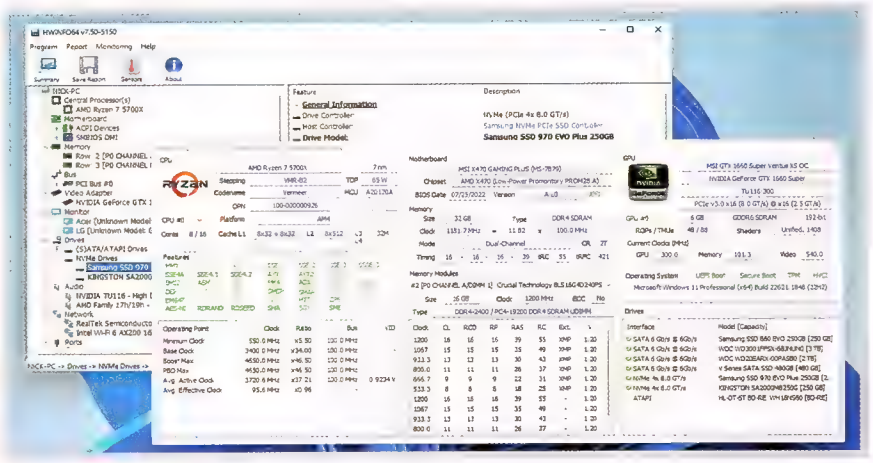
Once your system has been profiled, the Summary screen will display a three-paned window presenting information about your CPU, motherboard, and GPU. This provides quite detailed information about all three components – for example, the CPU pane displays your processor model, its TDP (thermal dynamic power), platform, and supported features, as well as clock information.

The Motherboard section reveals what chipset is powering your motherboard, as well as information about your system RAM: how much, its type, and clock speeds, whether it's running in dual-channel mode, and timings. Beneath this, the Memory Modules section lets you examine the capabilities of each individual stick.

Finally, on the right-hand side, you'll see information about your GPU, including the PCIe bus it's on and its underlying architecture. You'll also see at-a-glance information about your storage, boot setup (including whether it's configured for UEFI and Secure boot, and if a TPM is present), and finally a Windows version and build number.

TAKE A DEEPER DIVE

This is all useful information, but it merely scratches the surface of what HWiNFO can tell you about your system.



Get a detailed summary of your system with HwINFO.

Switch to the main window, which works in a similar – but dare we say it, more logical – fashion to Device Manager.

You'll see categories for your CPU, motherboard, memory, bus, video adapter, monitor, drives, audio setup, network, and ports, covering just about every aspect of your PC. While the System Summary provides a pretty detailed overview of your key components, it barely scratches the surface of what you can find out here.

For example, if you expand Motherboard > SMBIOS DMI and select BIOS, you can get details about your motherboard's current BIOS version and TPM version. Turn your attention to the System Slots section, and you can get an overview of what PCI-E and non-storage M.2 slots you have, and what cards or chips are currently populating them.

It's worth running through each section to see what kinds of information are available. One particularly useful section is Ports > USB. Here, you'll see a list of all your USB controllers, both those provided by your motherboard and any third-party cards you've plugged in. You'll see each controller's manufacturer and speed at the top level, and by expanding them, followed by Root Hub, you'll see which devices are attached to which controller. This is handy when troubleshooting problems that seem to only affect certain USB devices.

PRODUCE A SYSTEM REPORT

No audit is complete without some kind of report, and HWiNFO has this covered, too. Click the Save Report button to get started. Choose your output format – the default HTML produces a neatly formatted report, but other options – including CSV for a spreadsheet, or a simple summary copied to the Clipboard – are also available. Click Next.

Most options will then display a list of components to include in your report, which you can check or uncheck as required before clicking Finish. If you choose the summary option, you'll get a basic list of info about core components for copying to the clipboard, before clicking OK.

Whichever format you choose, you'll output a potentially lengthy document listing everything you'd see in the program itself. The default HTML version – which you'd view in your browser—does helpfully provide a clickable Table of Contents list at the top to allow you to jump to the specific parts of your system that interest you.

AUDIT YOUR NETWORK

A key part of your hardware is your network – so when it comes to auditing and maintaining it, you need to cast a wider net than just your main PC. We recommend the open-source NETwork Manager (**https://github.com/BornToBeRoot/NETworkManager**), which has all the core tools you need.

"ON FIRST LAUNCH, YOU'LL GET AN OVERVIEW LISTING YOUR PC, ROUTER, AND PUBLIC IP ADDRESSES."

On first launch, you'll get an overview listing your PC, router, and public IP addresses, along with any DNS information. Below this is Network Interface providing three tabs. Information is self-explanatory, while Bandwidth allows you to monitor downloads and uploads. Configure provides a section for configuring the various network interfaces on your machine.

Beneath this is Wi-Fi, which is useful, as it lists all visible networks and helps you see which channels are congested via its Channels tab. If you want to move your Wi-Fi network to a less congested channel, however, you'll need to manually log into your router to do so.

Below this is a tool for scanning your network to see what devices are currently connected – you'll get their IP address, hostname if one

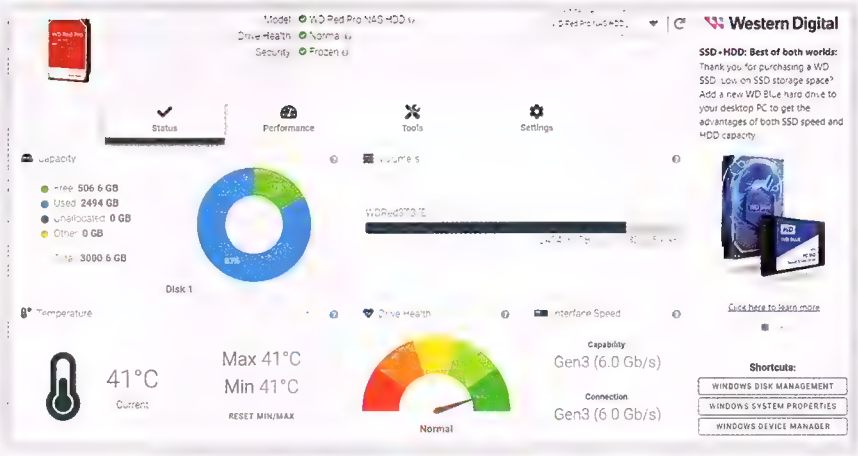
MONITOR SYSTEM HEALTH

Once you've audited your hardware, you'll want to look at ways of keeping an eye on it going forward – and HWiNFO can help here, too. Specifically, its Sensor window lets you monitor temperatures across your PC – you'll see them fluctuate in real-time, but it also records any maximums, allowing you to spot spikes in temperature that might herald problems, as well as log temperatures over a set period.

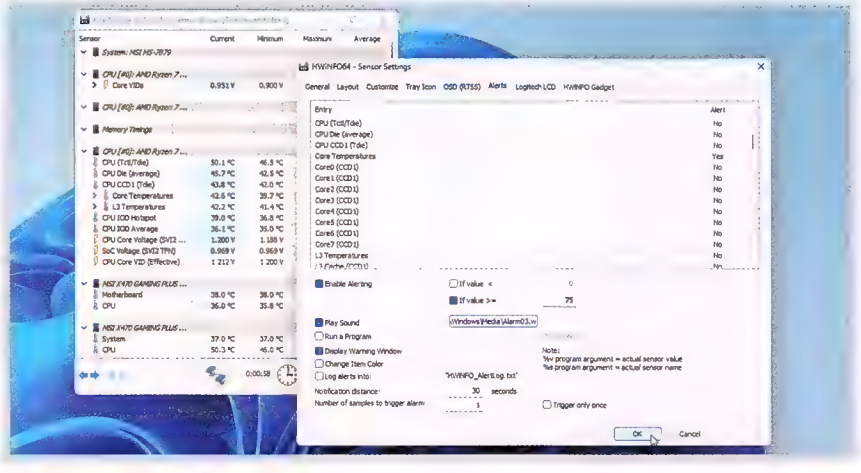
Of course, you won't necessarily want to spend your time keeping close tabs on your system, but would probably prefer to be notified should any specific problems be encountered. HWiNFO allows you to set up your own customised alerts, so you get to choose what changes trigger warnings. Click the Settings button on the Sensors window and switch to the Alerts tab, where you can configure alerts for everything shown in the Sensors window, including temperatures and voltages.

It's also possible to set alerts for your drives based on their SMART values, but first you'll need to switch back to the Layout tab to add the required entry – select items from the Hidden Items pane and check 'Show' to bring them into view and make them selectable under Alerts. Items to consider include Drive Remaining Life, Drive Failure, and Drive Warning. You'll see these items appear multiple times – one for each drive – so you'll need to add them all in.

When enabled, alerts can be configured to trigger a variety of events, from playing a sound to displaying a warning window. How you respond to the alert obviously depends on what the trigger is – signs of a drive failing require immediate backup of data and replacement of the drive, while temperature alerts indicate a need to check inside your case. The usual warnings apply – make sure your PC is fully powered off, and earth yourself before opening the case.



Each drive manufacturer provides its own tool to manage your drives.


HWiNFO can be configured to alert you based on sensor readings.

Start by ensuring any dust is carefully removed by following the guide on PC Gamer (**www.pcgamer.com/how-to-clean-your-computer-case**). Make sure there's plenty of space between components – tie back cables if necessary or re-route them away from your CPU and GPU if possible. Also, check that existing fans are working as they should, and that case fans are configured so cold air is drawn in one end and warm air is pulled out from the other.

It might also be a good time to investigate new cooling methods – is there room in your case for another fan, or do you simply need to explore more effective cooling (particularly if you have plans to overclock your system)?

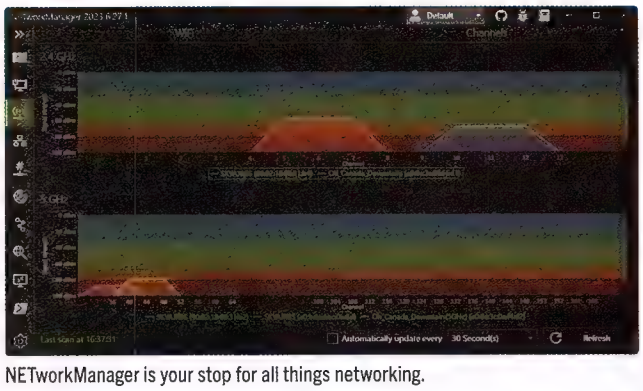
MONITOR KEY COMPONENTS

While HWiNFO provides a good overview of your hardware's health, it pays to explore other available tools that focus on specific parts of your system.

is provided, plus port status (open or closed), and whether they're contactable via a simple ping. If any aren't identifiable, switch to the ARP tool, where you'll see a list of IP and MAC addresses. Right-click your device, choose Copy > MAC Address, then switch to the Lookup section and paste in the MAC address to list its manufacturer.

We also recommend you look at Connections, where you'll be able to see precisely what your PC is connected to – both locally and over the internet, and on which ports.

There are too many tools offered by NETwork Manager to list here – you'll probably find it renders many existing networking tools like Putty for ssh connections redundant. Visit **https://borntoberoot.net/NETworkManager/Documentation** for comprehensive documentation.


NETworkManager is your stop for all things networking.

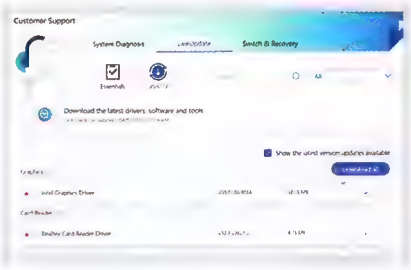
Take your hard drives, for instance – all major manufacturers provide dedicated tools for monitoring and tweaking hard drives, particularly SSD and NVMe models.

Identify the manufacturer of your drives, using HWiNFO if necessary, then visit the manufacturer's support pages to find out what utilities are available for monitoring and testing the drive. Examples include Samsung's SSD Magician (**https://semiconductor.samsung.com/consumer-storage/magician/**), Western Digital's Dashboard (**https://support-en.wd.com/app/answers/detailweb/a_id/10346/**), and Kingston's SSD Manager (**www.kingston.com/en/support/technical/ssdmanager**).

These tools provide more than just detailed system health reports about your drives – they're a convenient way to apply firmware updates, run SMART tests (short and long), and give you options for enabling 'over provisioning', which can extend the length of your SSD drives in exchange for giving up around 5-10 percent of drive space.

If you're looking to test your RAM for potential errors that indicate a hardware fault, use Memtest86+ (**www.memtest.org**). It's based on the original PCMemtest project, but unlike PassMark's variant (Memtest86), is free – and open source. You'll need to create bootable installation media to use it – the simplest solution is to download the ISO file and incorporate it into your Ventoy-powered rescue disk.

Want to keep tabs on your graphics card? MSI Afterburner (**www.msi.com/Landing/afterburner/graphics-cards**) is just the tool – not only can you use it to keep tabs on key stats like voltage and temperature, it can display framerates during games (make sure you've checked the 'RivaTuner Statistics Server' during setup), and can also be used to rein things in if your card is being pushed too far through settings to limit power output and temperature.



Look for a PC or mtherboard manufacturer utility to update core drivers.

We'll look at it in more detail later.

One often overlooked part of your hardware is the monitor. Given that you can spend hours each day glued to it, it pays to make sure it's configured correctly. Open your browser and navigate to **www.eizo.be/monitor-test/** to run the Eizo Monitor Test. This comprises nine different tests designed to make sure your display is both calibrated correctly and isn't suffering from defects like dead pixels. You can run the tests individually or go through them all.

If you run into problems that are the result of miscalibration, consult the monitor manual or visit the manufacturer's website for details on how to correct it using the on-screen display.

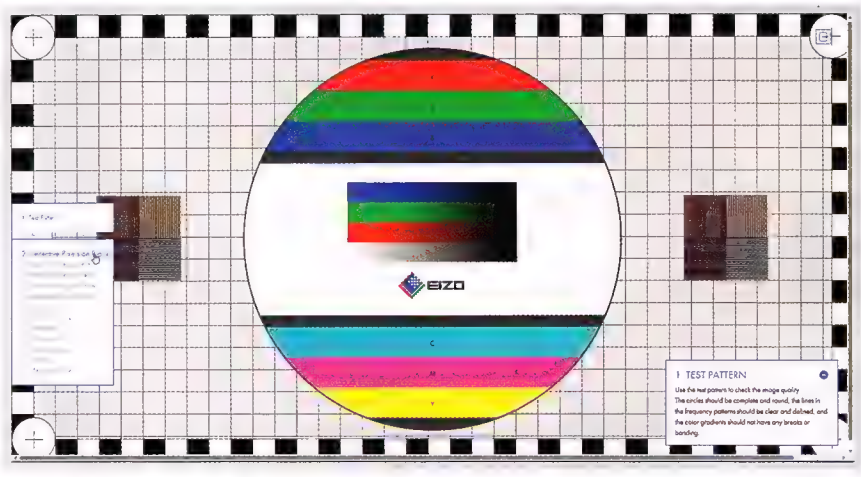
KEEP AN EYE ON YOUR BATTERY

If you own a laptop, then your battery is obviously another key component that needs monitoring. You can perform a quick and dirty check using the powercfg command-line tool. Right-click the Start button and choose Terminal (Admin), then issue the following command:

```
powercfg /batteryreport
```

Once the report has been generated, open your C drive and double-click battery-report to view a detailed report in your browser. The summary lets you see how far your battery has degraded by comparing its current 'Full Charge Capacity' with its initial 'Design Capacity', but scroll down and you'll see a graph revealing recent usage. Scroll down further to the 'Battery capacity history', which will show you how the battery's capacity has declined over time.

From this, you can extrapolate how much life remains in your battery, or utilise third-party software to do the calculations for you, amid other useful monitoring and optimising features.



Check that your monitor is calibrated correctly by using Eizo's free tests.

GIVE WINDOWS THE ONCE-OVER

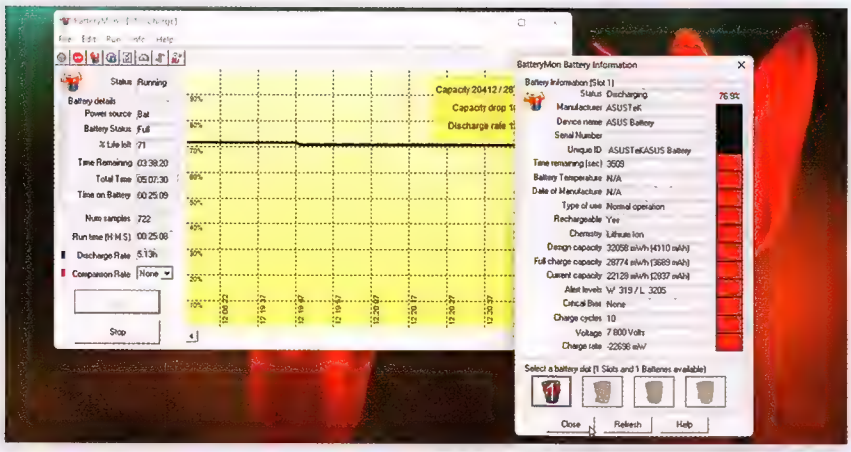
With your hardware checked over, it's time to move on to Windows itself. There are many built-in tools to help look at your operating system, but they're not all grouped together in one convenient place. For this job, we recommend tweaking.com's Windows Repair tool, which makes it easy to run these tests from a single spot.

After installing, reboot your PC into Safe mode – the quickest way to do this is to press Win-R, type msconfig, and press Return. Switch to the Boot tab, check 'Safe boot', and make sure 'Network' is selected before clicking OK and rebooting when prompted.

After you've logged into your user account in Safe mode, launch Windows Repair. We're not actually interested in its repair tools – although do explore them if you've been experiencing certain glitches or problems. Instead, work your way through the four steps, starting with the power reset, which is designed to drain all power (and possible glitches) from your system. Once done, you'll automatically reboot back into Safe mode, so launch Windows Repair again, and skip to step two.

Click 'Open Pre-Scan', followed by 'Start Scan' to perform three scans. If the Windows Package File scan finds any missing files, then make a note of the files and move on.

After you've performed your pre-scan, perform a disk check of the system drive (run it read-only to avoid a reboot – if any errors are found, then click the button to schedule a reboot for later), and round off your basic checks by allowing System File Checker to run.



BatteryMon gives you a visual overview of your laptop's battery.

One such tool – free for personal use – is BatteryMon (**www.passmark.com/products/batmon/**). Among its capabilities is a graph projecting the decline of your battery's charge over time – it can also monitor any UPS batteries plugged into your PC.

If you're willing to pay, Smarter Battery (US$14 after trial, **www.microsys.ro/smarterbattery.htm**) provides both monitoring and optimisation tools, designed to extend the life of your battery. It also provides a means of analysing battery performance over time, providing you with projections of its remaining life.

PERFORM A STRESS TEST

One way to check the health of your PC's components is through running a stress test. If you're a heavy duty gamer or dabble in high-end video editing, you'll already be pushing your PC to its limits on a regular basis, but if you're looking to overclock your system or are worried about recent instabilities potentially being linked to failing hardware, a stress test is the way to go to determine if there's an underlying problem that may need correcting (such as easing back on overclocked settings or improving cooling to key components).

Any benchmarking tool will do, but there are dedicated stress-testing tools too: BurnInTest (US$129 after free trial, **www.passmark.com/products/burnintest/**) is one of the most comprehensive out there, and aim firmly at professionals as well as enthusiasts, so you know you'll be well covered. BurnInTest goes way beyond the system's core components to include tests for peripherals such as webcams, USB ports, monitors, printers, and keyboards.

FREE STRESS TESTING

If you're operating on little (or no) budget, then you can still stress-test your core components: CPU, GPU, RAM, and hard drives. One free option is Jam Software's HeavyLoad (**www.jam-software.com/heavyload?ca=1**), which tests your key components from the CPU and GPU to hard drive and RAM. Portable and installer options are available – launch HeavyLoad and open the Test Options menu to choose which tests to run (CPU and GPU stress tests are enabled by default). Once done, click the play button to run the tests, which will run continuously until your PC falls over or you click the stop button.

Other tools worth considering for stress tests – particularly when overclocking your CPU and/or RAM – include Prime95 (**www.mersenne.org/download/#stresstest**). UNIGINE's real-time 3D engine can also be used for a wider stress test that encompasses the GPU, PSU, and cooling systems. It's free, and a variety of models are available, but check your hardware meets the spec before downloading one from its website (**https://benchmark.unigine.com/**).

When evaluating other tools, proceed with caution – for example, both IntelBurnTest (Intel CPUs, **www.techpowerup.com/download/intelburntest/**) and FurMark (GPU, **https://geeks3d.com/furmark/**) are known to push stress testing to extreme levels. You might get a quicker answer to your questions about stability, but only at the risk of potentially damaging your previously functioning components.

Whichever stress-testing tool you go with, it's a good idea where possible to keep a close eye on your components as the tests are being run – have HWiNFO's Sensors window open to monitor system temps, for example.

UPDATE HARDWARE

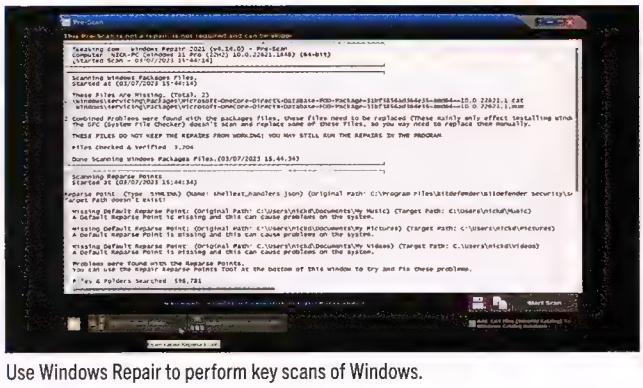
Once you're happy with the condition of your components, make sure the underlying firmware and software is up to date. When it comes to your motherboard's BIOS, you can get its current version (including date) from HWiNFO's Summary window. Head over to the support section of your motherboard's website and look under Support or Downloads to see what the latest version is. There may have been multiple updates since you looked – most updates add support for newer CPUs, but some can plug security holes and fix bugs.

The update procedure varies from motherboard to motherboard – some allow you to search for updates from within the UEFI itself (although be prepared to change server location if you

If it finds any corrupt files, it will fix them.

Once complete, we recommend opening any security tools that you have and running full scans while still in Safe mode before reopening msconfig to the Boot tab, unchecking 'Safe boot' and clicking OK to return to Windows proper.

"AFTER YOU'VE PERFORMED YOUR PRE-SCAN, PERFORM A DISK CHECK OF THE SYSTEM DRIVE"



Use Windows Repair to perform key scans of Windows.

run into an error while downloading an update), but most expect you to download the file to a flash drive and select it manually when you next boot into the UEFI.

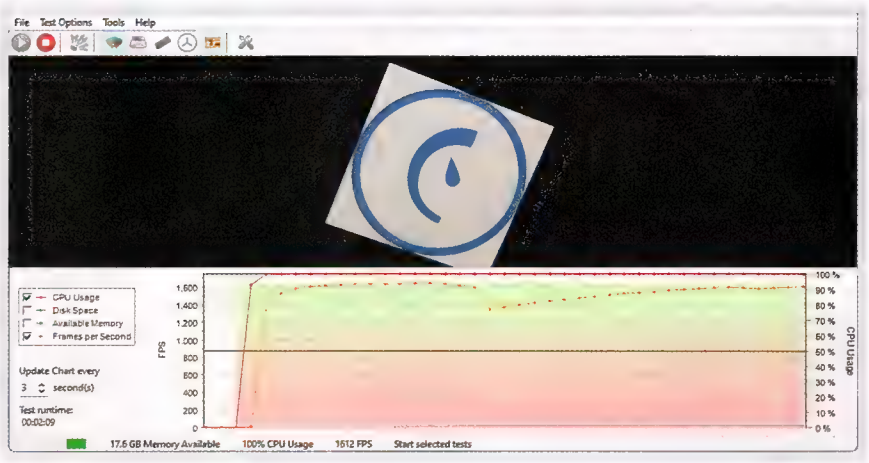
Hard drive firmware can be updated via manufacturer drive utilities, while the latest version of drivers can be sourced from a variety of locations. When it comes to your graphics card, installing a tool like NVIDIA's Control Panel gives you access to the latest drivers over and beyond those offered by Windows Update.

Your motherboard manufacturer may offer an all-encompassing driver updater tool, which should at ensure any onboard components like chipset and networking drivers remain updated going forward. Failing that, compare the version number of drivers offered on its website with those shown under Device Manager (right-click the Start button), which you'll find on the item's Driver tab on its Properties dialog.

If you're struggling to identify certain pieces of hardware – Device Manager is often quite unhelpful in this regard – head to **www.tweaking.com** to try its Hardware Identify tool. Launch this and click Update to update its database to the latest version before reviewing a complete list of all detected devices. These include 'standard system devices' like the power button or numerous 'PCI standard host CPU bridges' – filter the list by switching to the 'All Except Standard System Devices' tab.

Double-click an entry to reveal more about it – if you don't recognise it, then you'll see a list of possible matches shown, with the most likely match (or matches in the case of CPU models) highlighted in yellow. There's also a link to perform a Google search for the Hardware IDs associated with the entry, in case you're looking for more information online.

Hardware Identifier also identifies hardware devices with no drivers in place or problems – again, switch to the relevant tab to learn more. You may well see one entry marked as 'Unknown' with a Hardware ID of HTREE\ROOT\0—this can be safely ignored.



HeavyLoad allows you to stress-test core components.

If you're struggling to track down a specific driver, or feel too lazy to go hunting for drivers from different manufacturers and websites, consider a third-party driver updater tool. Many tend to be bundleware, which is why the safest tool for the job is also the least user-friendly, such as Snappy Driver Installer (**www.glenn.delahoy.com/snappy-driver-installer-origin/**) to update your drivers, including hard-to-identify ones.

TUNE HARDWARE PERFORMANCE

Once you're happy that your hardware is functioning correctly and has the best possible drivers installed, you may feel that you've done enough. But why settle for maintaining your hardware when you can tune it to boost performance?

The obvious solution is to overclock key components, most notably your CPU, RAM, and graphics. While this can be done from within your motherboard BIOS/UEFI, it's also possible to tune up your PC within Windows itself to save you the hassle of having to shut down and restart.

Before you begin, read the section on benchmarking your PC – this will allow you to compare your PC's performance before and after overclocking, allowing you to find a sweet spot between speed and system stability.

Once you have your reference benchmark in place, let's start overclocking your GPU with the previously referenced MSI Afterburner. It uses a separate tool – MSI Kombustor – to stress-test your overclocked settings, which you'll need to download from **www.geeks3d.com/furmark/kombustor/d.php**. You can run this standalone or access it via the 'K' button in Afterburner.

You can choose from a variety of stress tests, set your screen resolution, and choose what on-screen additions to include (we recommend checking 'Display GPU monitor graph' to monitor GPU temperature). Click 'RUN stress test' and see how the card performs at various levels and what temperature it's running at. You can also benchmark the system.

Press Esc to quit out of this and return to the main Afterburner dialog. From here, there are two ways to overclock your system – the first lets Afterburner determine the best

BENCHMARK: BEFORE & AFTER

When you come to tune your PC's hardware, you'll want to benchmark it before you make your changes to see what effect your overclocking has on your system. But it's also worth benchmarking your PC as part of your system checkup. In this instance, benchmarking in isolation tells you very little about the state of your computer, so it pays to benchmark every few months to see if performance dips during that period.

"A COMMON CAUSE OF SLUGGISH PERFORMANCE IS HEAT."

It's also good to compare the results of your benchmark with similar setups, so you can see if your PC is performing as it should given its spec. If your PC meets expectations, you can move on to overclocking and repeating the test to see whether you can eke out any noticeable performance gains.

If, on the other hand, your PC falls below expectations, it may indicate an issue that needs addressing. A common cause of sluggish performance is heat, resulting in thermal throttling as your CPU and other components deliberately slow down to prevent damage. If the temperature readings from HWiNFO appear to support this, open your PC case and make sure it's dust-free and everything is working.

settings for you. To do this, click the OC Scanner button on the left followed by Scan. Once complete, Afterburner will have applied a modest overclock, which you can benchmark and stress-test using Kombustor.

If you're looking to push things further, then you can use the sliders on the main Afterburner screen. Give yourself more headroom by nudging the Power Limit and Temperature sliders up, then start to play with the Core Clock (MHz) and optionally the Memory Clock too. Move upwards in small increments, and always stress-test your tweaks to get the right balance between stability and performance.

If you're looking to push things further, you'll want to boost your cooling options. Click Settings > Fan tab, check 'Enable user defined software automatic fan control', and create a steep fan curve to bring the fans up to full power to keep GPU temps down.

Once you're happy with your overclock, click the floppy button at the bottom of the screen to save it to one of the four available slots on the right. Once saved, click the revert button to go back to normal settings. Going forward, you can invoke the overclock when you need it (for gaming, say) simply by clicking its button followed by Apply.

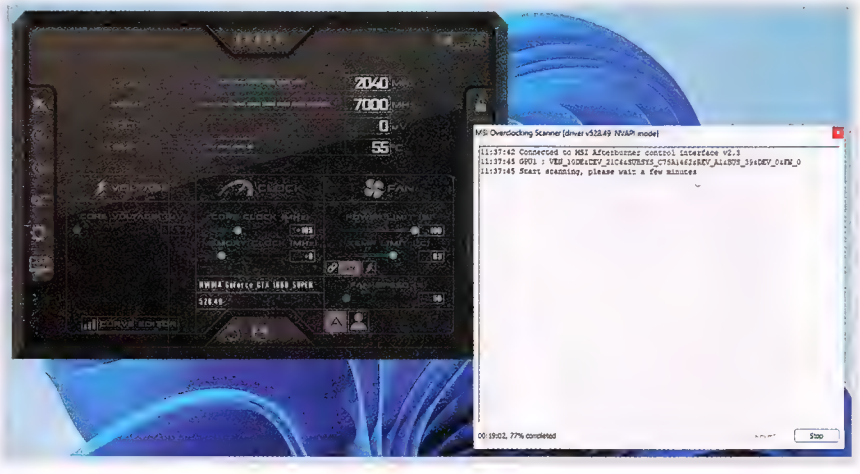
Hardware Identify might help track down unknown device information.

OVERCLOCK YOUR CPU

You can overclock your CPU directly from your PC's BIOS/UEFI, but an easier option is to make use of the Windows utilities on offer from your CPU manufacturer, namely the Intel Extreme Tuning Utility (**www.intel.com/content/www/us/en/download/17881/**) or AMD Ryzen Master (**www.amd.com/en/technologies/ryzen-master**). Make sure your CPU is supported by checking the compatibility list – more AMD chips are covered than Intel ones.

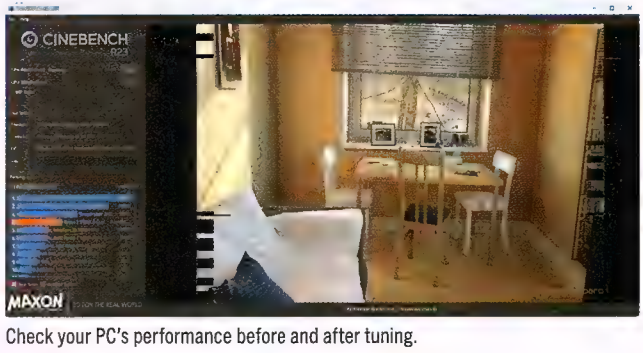
Intel's XTU comes with built-in benchmarking so you can compare the effects of overclocking on your system, while Ryzen Master offers basic and advanced modes depending on how technical you want to get. Version 2.9 of the latter also introduces a new 'Curve Optimiser Mode' option for the latest 5000-series CPUs and above, which allow you to further tune the overclock.

When you switch to Advanced view in Ryzen Master, be sure to click Help for a detailed guide about how to proceed. Two built-in presets – Creator and Game – are supplied, with room for two additional profiles if you want to push the envelope even further. Remember that overclocking is done entirely at your own risk – consider upgrading your cooling if you've not done so already.


MSI Afterburner can automatically configure a modest overclock for you.

When it comes to benchmark software, there's a range to choose from. PC UserBenchmark (**www.userbenchmark.com/Software**) lets you compare your system with other users, although there have been controversies about the weighting of its results. However, for the purposes of comparing like for like, it's a good choice – and free.

Other options include Cinebench (**www.maxon.net/en/cinebench**), which is also free, but CPU-focused, along with MSI Kombustor for your GPU. Don't forget MSI Afterburner's real-time FPS counter to measure real-world improvements when playing your favourite games.



Check your PC's performance before and after tuning.

SAVE YOUR OLD PC!

Give your hardware some extra longevity. Jonni Bidwell shows you how Windows fails and Linux Mint prevails.

It is the season of rejuvenation and a time for investing in new hardware. That dusty Windows 7 PC might be destined for landfill, or perhaps your Windows 10 machine is struggling. Slow PCs are a nightmare to use, and we understand the temptation of out with the old, and in with the new.

If 'the new' is a new Windows machine, we urge caution. Many of us can't afford shiny new computers. But with a little hardware refresh and the power of open source software, old machines can be granted a new lease of life. Linux Mint is easy to install, simple to use, and doesn't spy on you. With a couple of sticks of memory and a solid-state drive (SSD), we'll show you how it can make your old machine fly (not into a dumpster).

OLD HARDWARE vs NEW SOFTWARE

Microsoft would love you to buy a new Windows 11 PC, but your old hardware can find a new lease of life.

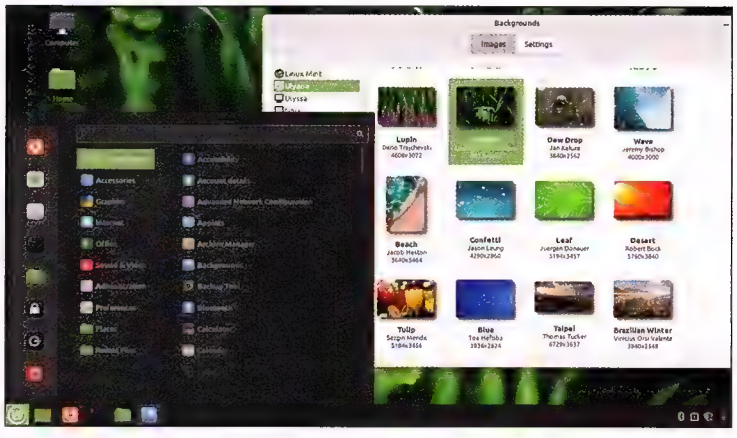
When Windows 10 was released, Microsoft quite clearly said that this would be the final version of the OS. This turned out to be a poor marketing strategy, and soon rumours of Windows 11 began to circulate. The software was eventually released at the end of 2021, and many Windows 10 users now live in fear of a phantom forced update to the new release by night.

Windows 10's hardware requirements were quite low, largely on account of Microsoft understandably wanting to get as much of its userbase on to the same version. If you want to install Windows 11, though, it's a different story. We can forgive the 4GB of RAM and dual-core, 64-bit processor stipulations – that's in line with what you'd want to run a modern desktop environment on Linux. We can also forgive 64GB of storage, but only because storage is cheap these days. What draws our ire is the need for UEFI Secure Boot and, in particular, a Trusted Platform Module (TPM) 2.0 chip. UEFI has been around for a decade (though not everyone likes it), but compatible TPM chips have only gone mainstream over the last five years.

FAREWELL TO WINDOWS

It is possible, via editing of ugly registry keys during installation, to bypass any or all of these requirements. But this isn't something your average user is going to know how to do. Nor might they want to – such a configuration is unsupported by Microsoft, and it claims "is not entitled to receive updates". Anecdotal evidence suggests such installs have in fact received security updates, but it's not at all given that this will continue. The upshot is there's a whole host of very capable hardware stuck running Windows 10, and when that goes EOL in 2025, that hardware will have to exit the Microsoft ecosystem, one way or another.

We've long touted Linux's ability to run on older hardware, so naturally we implore anyone feeling disgruntled about not qualifying for Windows 11 to give it a whirl. Anything that ran Windows 10 can run Linux Mint without a care. Things are not so simple once we start looking at hardware from previous epochs, though. Up until around 2004, most x86 PCs had 32-bit processors, which is to say that at the lowest levels, they operated on binary 'words' 32 bits long. These words were not long enough, so the x86_64 architecture was born, and by 2006, very few 32-bit x86 CPUs were being produced. Windows 10 still supports 32-bit machines, as do many versions of Linux (Debian, Gentoo, PCLinuxOS). However, many popular Linux distros, in particular Ubuntu, Fedora, and Arch, do not. We're going to look at Linux Mint over the page, our go-to distribution for beginners and those fleeing Windows. Mint's main release is based on Ubuntu, but it has a lesser-known Debian-based release that works in much the same way. This is what we recommend for your 32-bit boxes.



Don't judge a book by its cover, but by all means judge Linux Mint by its incredible background selection.

> "We've long touted Linux's ability to run on older hardware, so naturally we implore anyone feeling disgruntled about not qualifying for Windows 11 to give it a whirl."

VERY OLD HARDWARE

It's well documented that Linux came into being by way of Linus Torvalds's 386 PC in 1991. In the beginning, this was the only hardware that the OS supported. Soon, it was rewritten in portable code and ports to the Motorola 68000 IBM s/series, and other platforms duly appeared. It might have been a sad day, then, when in 2012, 386 support was dropped from the kernel. Linus didn't seem to think so, though, as he bid it and its ugly memory management good riddance. So no, you can't run (modern) Linux on a 386 today.

The kernel supports 486s and early Pentiums, but you'd run into trouble running most distros on them. Distros that still provide 32-bit builds might still require CPU support for physical address extension (PAE), which is only present on Pentium Pro and later hardware, dating back to 1995. PAE allows more than 4GB of RAM to be addressed, although each program is limited to 4GB. This is where the misconception that 32-bit systems can't use more than 4GB comes from. You can disable PAE at the boot menu (and distros such as Bodhi's Legacy edition disable it by default).

Dinosaur-era CPUs that don't support multimedia extensions (like SSE introduced with Pentium III chips circa 1999) generally don't support video decoding, so can't run modern web browsers (which would eat their allotted 4GB of RAM anyway). Moreover, a world of pain awaits anyone trying to run modern desktops on old graphics cards or integrated chipsets.

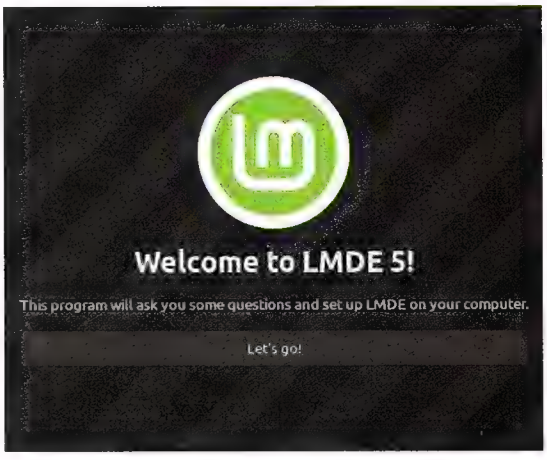
LEVEL UP YOUR LAPTOP

Let your laptop do a Lazarus with Linux Mint, even if it's 32-bit vintage.

Imagine that you have an old laptop lying around. Suspend your disbelief and imagine further for a moment, against all odds, that you find its power supply, too. As you draw a deep breath and hit the (rather dirty) power button, the machine whirrs into life and a legacy BIOS logo appears on the screen. As the lengthy boot process ensues, the screen flickers and the hard drive chugs in an increasingly agitated fashion. A fan, reacting to the arduous work the CPU below is doing, spins faster and faster, emitting an unsettling whine. Exactly where our imaginary tale goes from here is up to you, but if you have an old laptop that seems to work, there's a good chance it can be made a lot more useful with Linux.

Before addressing the software, it's worth doing a hardware refresh as well. Compressed air through the vents and keyboard will clear out any dust, hopefully quelling that ominous fan noise. If you're feeling more adventurous, open your laptop so you can investigate more thoroughly. Don't spray chips and connectors at point blank range, though, as some are quite sensitive.

Any PC upgrade should include a RAM boost. Indeed, if you were going for a bang-for-buck upgrade, RAM should be where you invest the most, so find out how much memory (Crucial's System Advisor has served us well in the past: **https://www.crucial.com/upgrades**) you have and how much your laptop model can handle. Most serviceable laptops have a convenient memory port on the underside. Open this to see how many slots are available for new SO-DIMMS (small outline dual in-line memory modules). They may all be populated (for example, two slots with a 1GB module in each), in which case you'll probably want to discard both modules and replace them with something more capacious (such as two 4GB modules, if supported). When buying more RAM, get the correct DDR version and frequency for your hardware. Unlike the old days, it's possible to mix and match module sizes, but it's best to use a matching pair (or pairs/a quartet if your laptop has four slots).

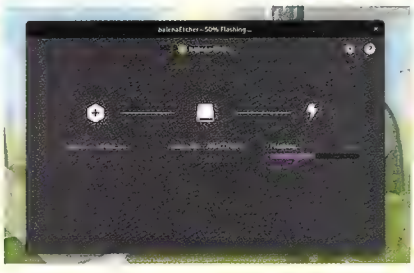


Your laptop's new life begins here. The installer walks you through the journey with ease.

BOOT LMDE 5

1. DOWNLOAD THE IMAGE

The LMDE download page is at **https://linuxmint.com/download_lmde.php** (or go to the main page for the official Ubuntu flavor). Hit Download, then fetch the torrent or choose a mirror (further down the page) to download the ISO file. You may have a tool for writing it to USB; if not, grab the cross-platform Balena Etcher from **https://etcher.io/**.



2. FLASH THE IMAGE

Start Balena Etcher (if you downloaded the AppImage, you need to **chmod +x** it; see the Etcher page for info), and point it to the LMDE image. Select your USB storage (hard drives and SSDs are marked with exclamation marks, so you don't do something you regret) and hit Flash. Wait for it to finish and verify, then reboot the machine.

3. BOOT THE LIVE ENVIRONMENT

If you press F12 or F10 quickly enough, you might see a handy boot menu appear, which enables you to boot your freshly minted USB media directly. If not, you need to reboot and change the boot order from the BIOS or UEFI interface.

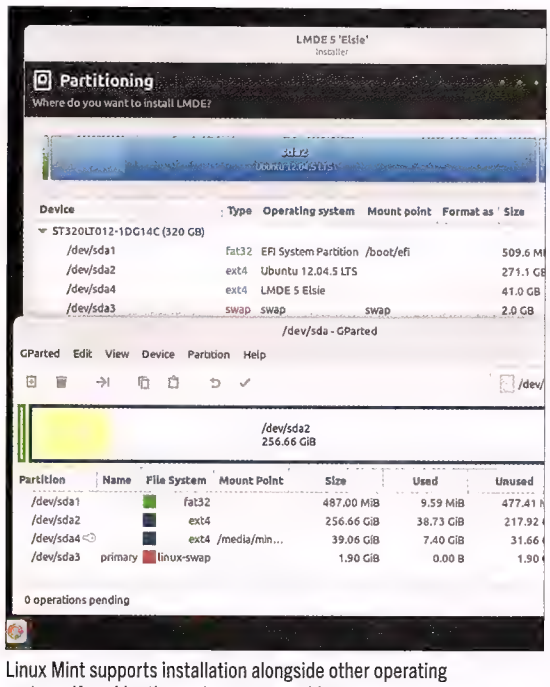
If successful, select Start LMDE from the boot menu, and await the friendly startup chime.

It's generally not possible to upgrade CPUs on laptops (old desktop upgrades tend to offer only minor speed bumps), so the next bit of hardware we'll address is that noisy hard drive. If your laptop has a 2.5-inch SATA bay inside, you can replace the incumbent drive with an SSD. Not only is this quieter, it's faster. If your laptop supports SATA 3, you'll enjoy read speeds of around 500 megabytes per second. If it doesn't, don't worry – modern drives are all backwards compatible, and you'll still enjoy their quieter operation. SSDs are remarkably cheap, too; canny shoppers can pick up a 240GB model for $25. Speaking of cheap, budget laptops of old tend to be sealed units that can't be readily upgraded, so don't try too hard to open these models. If you can get in without breaking it (they often are glued), you may be disappointed to find soldered-in RAM and storage.

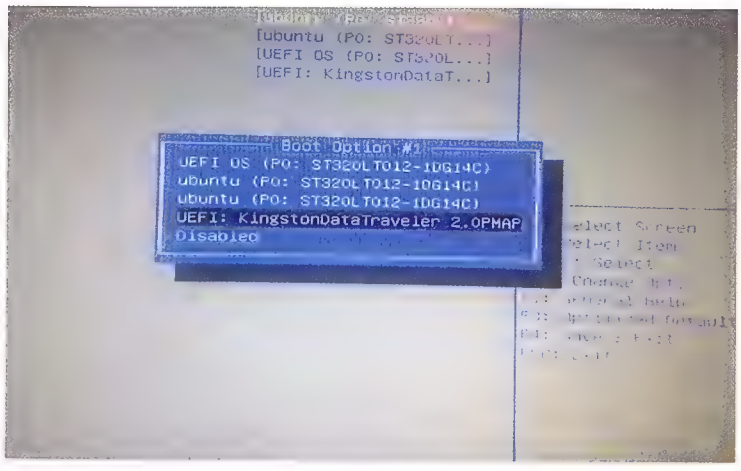
TAME YOUR UEFI

Before replacing your laptop's storage, check to see if there's any important data on there. You can always plug it in later (with a SATA-USB adapter), but you might also want to boot up the old OS to export browser passwords, bookmarks, or cryptocurrency wallets. Once you've upgraded your machine's insides, power it on and follow any on-screen guidance to enter the setup. Often this is done with Del, F10, or F2, but some devices require a more radical combination. Older machines have a BIOS (Basic Input/Output System) set up, while newer ones use the Universal Extensible Firmware Interface (UEFI).

Either way, you should be able to check that all RAM modules and the SSD are detected. There might be the option to tweak RAM timings, but this generally isn't required. It's possible, though unlikely, that your machine needs a firmware update to support some new hardware. UEFI machines often allow such updates from a USB stick or the OS. BIOS machines often need to be booted to a DOS-like environment (such as FreeDOS) to apply updates, which is beyond the scope of this outing. UEFI machines can emulate BIOS machines through a legacy mode. We don't recommend doing this unless you have reason to.



Linux Mint supports installation alongside other operating systems if you'd rather not erase everything.



We dug out this decade-old laptop just to photograph its classy UEFI configuration.

UEFI is often criticised for its Secure Boot feature, which determines what operating systems are allowed to load. Many Linux distributions (including LMDE, which we'll look at in a moment) work fine with Secure Boot, but some don't, so you may want to disable this if you plan to distro-hop. Assuming everything looks fine in the firmware, we can move on to installing our minty-fresh OS. We'll look at the flagship edition of Linux Mint (based on Ubuntu) over the page, but just to mix it up, we'll use the slightly more adventurous Debian edition (LMDE) to enliven our laptops here.

EVERYONE LOVES LINUX MINT

Apart from not liking Ubuntu, one reason to use LMDE is that it still supports 32-bit hardware. LMDE also follows Debian's release cadence, rather than that of the Ubuntu LTS, so most of the time, LMDE has older software than its Ubuntu counterpart. LMDE 5 (code-named Elsie and released in March 2022) is based on Debian 11, Buster, released in August 2021, as opposed to the Ubuntu LTS, which appeared in April 2022. Don't let this bother you – there are always ways to add new apps.

Follow the walk-through (opposite) to download LMDE 5 and start its live environment (these work on Linux and Windows). You can mess around here as much as you like without worrying about messing up your system. Nothing is written to the main storage (a RAM disk is used) until we install it, so it's worth taking time to explore the Cinnamon desktop environment. It comes with everything you need for bread-and-butter computing, and is intuitive to navigate. You probably don't need us to tell you that Wi-Fi networks can be found in the system tray in the bottom-right.

When you're suitably impressed with LMDE, double-click Install Linux Mint, then click Let's Go. You're greeted with a series of localisation questions. If you're connected to the internet, the correct regions should be selected automagically. Next, you need to come up with a name for your computer, a username for yourself, and a password for your computer.

We're not going to cover advanced partitioning setups or dual booting; we'll just go with the Automated Installation option, which wipes your entire disk. If you know what you're doing, you may prefer to use the Manual Partitioning option here. Hit Next and heed the final warning before commencing the installation. Assuming that all goes well, you can reboot into LMDE at your leisure. The next pages are packed with tips about what to do with this fresh new operating system.

DEGAUSS YOUR DESKTOP

Say hello to Linux Mint 21 Vera, here to modernize your desktop PC.

Desktop systems are usually a little more flexible, upgrade-wise, than laptops. There's generally a lot more room to look around, which means a lot more space for dust to gather, too. RAM and SSD upgrades will probably, again, have the biggest impact, but you may also be tempted to replace your processor. If you want to get into gaming, you might want to put in new graphics card. Heck, you might want to rip out all the guts and replace the motherboard and everything else mentioned hitherto.

There certainly are bargain components to be had on auction sites and marketplaces, but these may be damaged and unscrupulous sellers will not refund you. Bear in mind also that components have a limited lifespan. Capacitors on motherboards pop, power supplies (PSUs) fail, and fans become noisy. Rather than entrusting your critical business to hodgepodge hardware, we strongly advise getting new parts. That notwithstanding, going Frankenstein on older machines is fun, and you probably can't buy new components for them easily. Just don't use said the resulting Franken-puter for anything crucial. Oh, and consider power efficiency – they may not need a lightning strike to come to life, but older machines aren't as good at saving power when idle as their newer counterparts.

Cinnamon enables you to disable this kind of desktop po-up, which is useful if your GPU is very old.

However you choose to source your components, it's of paramount importance to check compatibility. If you get the fastest possible CPU for a given motherboard, that board may need a firmware update in order to work with it. If you get a fancy graphics card (see box), you may need extra PCI Express power connectors (or a whole new PSU) to power it. If it's a chunky, fancy graphics card, there may be space considerations. If you're getting a new heatsink or fan (or investing in watercooling), this can be an issue, too.

As with upgrading RAM on laptops, take care to ensure compatibility. Modern mobos might let you run four 8GB DIMMs in quad-rank quad-channel quad-damage mode (one of those isn't real), but this is only going to benefit specific applications. The minimum we recommend for a desktop machine is 16GB. We can hear some of you crying overkill, so let us explain: you can certainly run a lovely desktop with four, but a modern web browser will eat that up in no time. You may not be interested in using the machine as an everyday desktop, in which case you can get away with less. Linux Mint installs on a machine with only 2GB, and there are lightweight distros that require even less.

We're going to pretend we've installed the flagship edition of Linux Mint on our freshly upgraded machine. This only supports 64-bit machinery, so if you have a 32-bit machine, use the three-step guide for the Debian edition on the previous page. In fact, use those instructions for the flagship Ubuntu edition, too – they have been made just about recyclable in this case. Again, take some time to enjoy the live environment and get a feel for how things

UPPING YOUR GRAPHICS GAME

Modern integrated graphics are surprisingly good, as in playing AAA games at 1080p good. These days, they're part of the CPU package, but in times gone by, they were integrated on the motherboard, and they weren't that good. If your machine has such hardware, you may want to upgrade to a beefier GPU, in which case you may well want some information about drivers.

AMD and Intel (who now produce discrete cards, too) have long contributed open source drivers to the Linux kernel, so you should expect their cards to work out of the box. Nvidia hardware ought to work, too – its proprietary drivers are now bundled with Ubuntu. Check this from the Driver Manager in the Administration section in the main menu. You may be using the open source Nouveau driver instead. This is fine unless you need 3D acceleration, in which case you can switch to the naughty proprietary kernel module. There's an official PPA if you want a bleeding-edge graphics stack – see **https://launchpad.net/~graphics-drivers/+archive/ubuntu/ppa**.

The Windows way of downloading drivers from manufacturers' websites is largely frowned upon in Linux. Open source drivers (for all hardware, not just GPUs) are included in the kernel, and distros do a fine job of making sure these work out of the box. Ubuntu includes lots of proprietary drivers and firmware, too, so you shouldn't need to go hunting around the internet for hardware that needs these. There are always exceptions, though – some Wi-Fi devices need firmware that can't be redistributed, so you need to extract this yourself.

A modern motherboard's UEFI interface even allows you to take screenshots.

work in the spicy Cinnamon desktop (or mighty MATE or excellent Xfce desktops, if you fancy trying a different flavour).

The live environment comes with most of what you'll find once Mint is installed – that is to say, everything you need to conduct your digital business. There's Firefox (the thinking person's web browser), the LibreOffice suite (almost entirely compatible with Microsoft Office and cloud office offerings), and all the usual de-rigueur tools and utilities. Don't worry if it seems a little slow and clunky – this is mostly because it's running from USB. Once properly installed, the experience will be much smoother.

Apart from a slightly slicker installer, the process for the Ubuntu edition is much the same as the Debian-based situation on the previous pages. Just hit the Install icon on the desktop. We won't cover complex partitioning arrangements, as we'd be here all day, but we will say be very careful if you're setting up dual boot, especially if your plan involves resizing Windows partitions. We strongly recommend using a new drive dedicated to our imminent Mint install instead. Either way, we'll reiterate our advice to back up anything important before installing a new OS.

Having been gently guided through the install process (see the boxout over the page if you want to tweak swap settings), reboot your computer and log in to your new operating system. You'll be greeted by the welcome wizard. Go to the First Steps tab, where you can choose between light and dark themes, or choose a highlight colour (for some reason, green is unpopular with Linux users – just ask the Bodhi Linux team).

Less cosmetically, you can also set up system snapshots with TimeShift from here. These defend against rogue system updates (which shouldn't happen, but do) and enable you to easily roll back the system to a known good state. TimeShift isn't ideal for backing up personal files and, by default, doesn't include your home directory, in order to keep snapshots small (though you can force its hand). A dedicated utility such as Déjà Dup (available from the Software Manager) is better suited to this task.

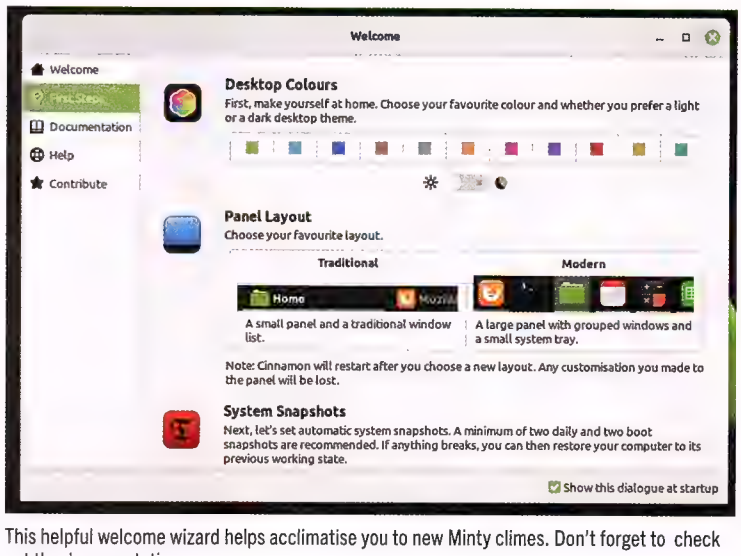
If you want to play certain media formats, you may need proprietary codecs to do so. These can also be installed from the welcome wizard. Most media from streaming sites uses freely licensed codecs (many patents have expired over the last five years), so this package is less important than it used to be.

Next in these first few steps is the Update Manager. Sooner or later, it will pop up to nag you, so you may as well do this now. It asks if you want to switch to a local mirror (for the Mint-specific packages, the underlying Ubuntu, or Debian, system is updated from Canonical's, or Debian's, repositories), which ought to speed up updates slightly. You'll probably be told that an (Inception-like) update to the Update Manager is available during all of this, but that should be swift and painless.

Mint 21.1 was released in December 2022, so the first lot of updates (if you didn't tick the Download Updates During Install box) might take longer than usual. Don't worry though, because updates on Linux are not the painful, hour-long, reboot-ridden trauma that they are on Windows. You are in control, but you should not ignore that little shield notification when it pops up. Exploits and malware do target Linux, and it's nice to get any bug fixes before the corresponding bugs bite you.

Some people integrate system updates into their daily practice, but so long as you update at least weekly, you'll be fine. Problems occasionally arise if updates are left for too long and transition packages are missed. It's rare these days (as long as you don't have an Nvidia GPU) for an update to result in the dreaded rebooting to a black screen, kernel panic, or GRUB rescue prompt, but so many forum posts affirm that it does happen. This is why you should heed our TimeShift advice. Even on an unbootable system, you can boot the Mint live environment and roll back your system from there. Assuming your system is bootable, head on over the page to put the final touches to your Mint install.

> "Modern mobos might let you run four 8GB DIMMs in quad-rank quad-channel quad-damage mode (one of those isn't real), but this is only going to benefit specific applications."


Welcome
Welcome
First Steps
Documentation
Help
Contribute
Desktop Colours
First, make yourself at home. Choose your favourite colour and whether you prefer a light or a dark desktop theme.
Panel Layout
Choose your favourite layout.
Traditional
Modern
Home
A small panel and a traditional window list.
A large panel with grouped windows and a small system tray.
Note: Cinnamon will restart after you choose a new layout. Any customisation you made to the panel will be lost.
System Snapshots
Next, let's set automatic system snapshots. A minimum of two daily and two boot snapshots are recommended. If anything breaks, you can then restore your computer to its previous working state.
Show this dialogue at startup

This helpful welcome wizard helps acclimatise you to new Minty climes. Don't forget to check out the documentation.

TWEAKING AND TESTING

Peek into Linux's internals and ensure your machine is healthy. Plus, learn some command-line secrets.

If you've followed along this far and your upgraded machine now boots Linux, connects to the internet, and doesn't crash, then bravo! You are doing better than us. If, on the other hand, something is not working as expected, you'll want to dig deeper with some diagnostics. Common sore points include (but are not limited to) audio, graphical stutter, disk space running out (this can happen very quickly if you try to squeeze Mint into a small space), and media not playing. Laptops have their own peculiarities, so make sure that your laptop's hotkeys (in particular brightness controls), Bluetooth, and Wi-Fi are all working as expected.

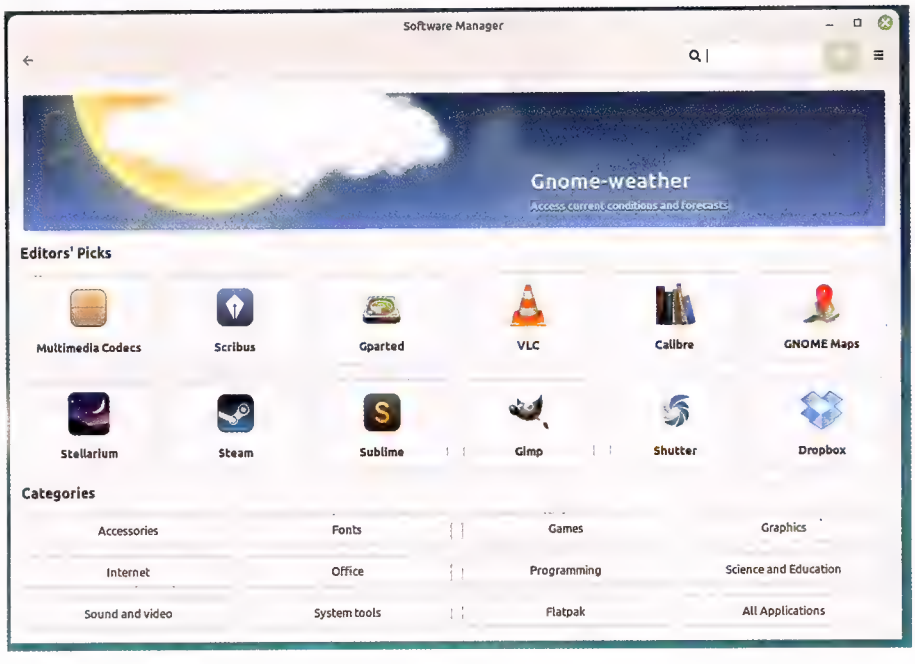
Hybrid graphics found on laptops have long been problematic on Linux. Nvidia Optimus laptops, for example, feature a low-power, integrated GPU and a gruntier discrete GPU from Nvidia. Ideally, the latter is only used when needed, preserving battery life. The Bumblebee project used to support this (at least for Intel iGPUs), though that project isn't being maintained these days. The Nvidia settings application enables you to set this up, and GPU offloading (where you can tell an application to run on the fast GPU) is integrated on the Gnome desktop. In theory, you can get this to work anywhere with some command-line fu.

Oh, and if everything grinds to a halt when you open a web browser, check out the box opposite about swap space. Browsers use a ton of memory, and any more than a couple of open tabs easily chews through 4GB. So, while memory-limited hardware is still good for a lot of things, browsing modern websites is not one of them. SSDs with fast random read and write speeds can mitigate the situation to some extent. You'll probably run into problems with the Mint graphical installer if you try to run it with less than 1GB of RAM, so here you'll have to recourse to a different Linux flavor. Bodhi Linux, Slax, and antiX do very well in these situations. Alternatively, you might prefer the 32-bit Arch Linux community flavour, if you're that kind of person.

Even if everything appears to work fine, it's worth looking under the hood to check everything is indeed okay. You'll find System Monitor in the Administration menu. This firstly provides a list of running processes and how much memory and CPU they're using. If things go awry, check here to see if a misbehaving program is hogging one of these resources. Move to the Resources tab to see overall usage figures and smoothly updated graphs. The File Systems tab shows you how things are going disk space-wise.

You might notice in here (or from your BIOS or UEFI) that not all your RAM is detected, in which case you should first check that it is seated correctly in the slots. If that doesn't fix it, you may have a dead DIMM, a dead slot, or just bad luck. Try swapping DIMMs around (carefully – they are sensitive to both static and being dropped or scratched) to isolate the problem. It's rare to run into compatibility problems on modern systems (beyond getting the wrong generation of memory; G.Skill has a configurator at **https://gskill.com/configurator** to help avoid this), but older mobos used to be fussy about this. You need to dig up the manuals in this case. Usually, RAM banks should be filled starting nearest the CPU. But this is not a universal rule, so the matter may be solved by shuffling DIMMs around.

To dig even deeper, open the System Logs application (also in the Administration menu) to see whether any programs or hardware are upset. In general, Linux writes quite verbosely in the system journal about what it's up to, so the System Logs application shows only the important messages when you open it. You can turn off the filter, or restrict it to other subjects from the list on the left. Even if there are some scary sounding alerts here, they might not really be a cause for concern. For example, our laptop complained about a missing PCM



Head to Mint's Software Manager to find and install all kinds of wonderful applications.

device (because it doesn't support 7.1 sound) and debug firmware for the Wi-Fi (which we didn't want to debug). Newer messages are listed first, so it can be helpful to watch this while opening problematic applications and such. If your machine is subject to random crashes (not that Linux ever crashes), you might be lucky enough to catch a telltale error message here when it does.

We haven't mentioned it yet (because market research shows it scares people off), but you can do pretty much everything and anything from the command line in Linux. The system can be monitored with **top**, updated with **apt**, and have its logs scrutinised with **journalctl**, for example. The terminal program (found on the shortcut bar next to the Firefox icon, or in the Administration menu) is our gateway to command-line interactions. Let's use it to install some software that will help with our cursory diagnostics.

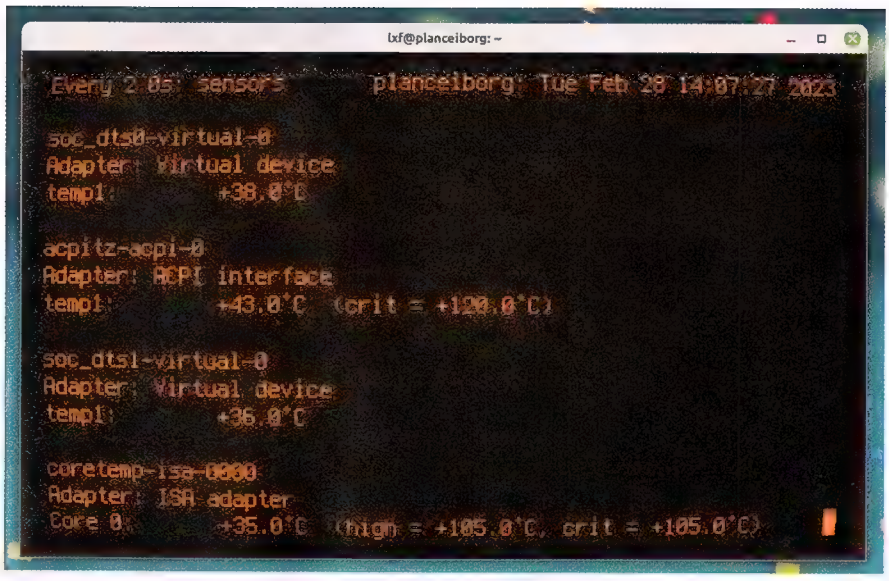
Assuming your system was recently updated, typing **$ sudo apt install lm_sensors** should first give you a stern warning about power and responsibility. You probably found yourself having to type in your password more times than you felt comfortable with during the first update. This is because Linux takes security seriously, and the user needs to be aware when they're using their administrative privileges, so you won't mind typing it in again here. That's what the **sudo** command deals with, while the **apt install** part uses those privileges to install things, in this case the lm_sensors package.

LM Sensors is able to read sensors (temperatures, fan speeds, and other variables) from a huge range of hardware. It's been around for a very long time, and these days works out of the box for most hardware. Try it by running **sensors**. You should see a variety of potentially useful readings. If you see an error to the effect that no sensors were detected, try running the **sensors-detect** script first. To make this even more useful, we can use it as a real-time monitoring tool, by combining it with another command. Try running the following instead:

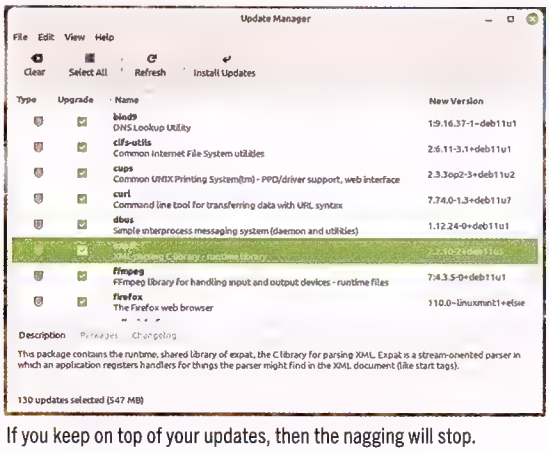
$ watch sensors

Hey presto, the lightest hardware monitor in the world. Try taxing your CPU or graphics card with this running to see how hot the machine's internals are getting. Of course, graphical programs are available that do this (such as Psensor), but command-line tricks like this are always useful. You can stop the sensor monitoring by pressing Ctrl-C.

The latest Linux Mint release, Victoria, is available to buy now. ■



For added pizzazz, run lm_sensors in CoolRetroTerm. You can almost feel the electrons burning your retinae.



If you keep on top of your updates, then the nagging will stop.

> "If everything grinds to a halt when you open a web browser, check out the box opposite about swap space. Browsers use a ton of memory, and any more than a couple of open tabs easily chews through 4GB"

SWAP SPACE

It's worth taking a moment to talk about swap space. Swapping (using disk space as memory when actual RAM is running low) has been a staple of computing since as long as there have been disks. No one has ever liked swapping (accessing disks, or even flash storage, is magnitudes of order slower than RAM), but it is marginally better than the alternative – having random applications summarily killed to reduce memory pressure.

A rule of thumb (with dubious origins) used to be that the operating system should have twice as much swap space as system RAM. This is still reasonable on old systems (ones with less than 4GB RAM), but for machines with 32GB, it almost certainly makes no sense to sacrifice 64GB of disk only for a tiny fraction ever to be used. A better formula for modern systems (with more than 8GB) is 20 percent of RAM. But it all depends on your (and your favourite applications') memory usage habits.

A default install of Linux Mint creates a swap file, and LMDE gives you a swap partition instead (on our ageing laptop, this was 2GB). It's easy to resize swap files (and not impossible to resize swap partitions), so you don't need to re-install if you have to change this. Don't worry if this all means nothing to you. You can find out more at **www.redhat.com/en/blog/do-we-really-need-swap-modern-systems**. Or, if you want to learn about the ins and outs of the installer, check the official documentation at **https://linuxmint-installation-guide.readthedocs.io/en/latest/**.

PC BUILDER

System News

Mark Williams is always checking for updates, sometimes they can give a nice surprise.

Mark Williams
Mark is an IT professional with a strong interest in voiding warranties.

Updates and new revisions to PC products and parts are commonplace, but how much do they really make a difference? The most common kind are driver updates. Even if the hardware undergoes no physical alteration since launch, drivers can make a huge difference to performance and stability. Typically, general overall performance can rise some five percent over the course of a year for graphics card drivers, but that glosses over double digit rises in individual games, not uncommonly in new game titles.

> "Some updates and revisions go completely under the radar, usually because they're stability or safety related – something companies don't want to admit to failing at."

Intel's ARC cards, for instance, have seen double and even triple digit percentage improvements since it was launched. Indicating how far behind Intel began on the driver front, but also the importance of continual improvements to match its competition.

Motherboards get their fair share of software, BIOS, driver and even physical board revisions over their lifetime too. Newer revisions aren't as common but do occur. Normally not much to write home about, as they usually focus on fixing stability or compatibility issues, but sometimes they are more substantial, like MSI's MAX series of AM4 motherboards which included a larger ROM chip so those motherboards could support the full list of AM4 CPU's along with the full UEFI interface where older boards had to compromise on both due to insufficient ROM capacity.

MSI's MAX series of AM4 motherboards included a larger than usual ROM capacity, allowing it to hold more data covering a wider set of compatible CPUs, thus extending the appeal of this series of boards.

More recently AMD has released new AGESA code for motherboard vendors to roll out which enables RAM support above the roughly 6,000MT/s from before up to 8,000MT/s and beyond, putting it on par with Intel's supported speeds. This kind of update is rare though and likely a one off for this generation, but it goes to show what's possible after release.

Some updates and revisions go completely under the radar, usually because they're stability or safety related – something companies don't want to admit to failing at.

For example, Nvidia copped flak for using the new 16-pin 12VHPWR connector which gained a reputation for melting and killing cards. While not strictly Nvidia's fault (PCI-SIG created the connector standard), since the launch of the RTX 4070 it has been selling cards with an updated revised 16-pin connector dubbed 12V-2x6 which is backwards compatible, but importantly alters pin lengths to ensure correct electrical connections to prevent such scenarios occurring. These will be standard on ATX 3.1 compliant PSUs and cards sporting PCIe 6.0, though are being implemented earlier by most makers.

Not only might new drivers or revisions improve performance, but new features may be added, and if stability is a problem, it's even more important. Tracking new revisions of hardware before purchase can be more difficult and usually not worth bothering with, as the newer version will typically supplant old stock quite quickly. ■

SHOP TALK

Do product updates/revisions typically help you provide more value or stability to your customers?

Jaimie, Leader Computers: "Normally when there are revisions like this it is because the performance at launch is not what has been advertised or hyped, Intel Arc drivers are a prime example, so they are expected by the gaming community and rarely a real marketing opportunity. We are excited about the AM5 AGESA update though, as that will add some unexpected performance capability rather than just getting up to what the community expected.

There have been times when revisions have been necessary to increase stability, the most common of these is normally mainboards although high end GPUs can also benefit from revisions for better stability."

© MSI

Market Watch

A sampling of PC systems available this month.

PLE COMPUTERS LUNAR

$3,489 | tinyurl.com/APC524PLE

PLE has found access to the RX 7900 GRE (Great Rabbit Edition), a mostly China-only exclusive card and has built a system around the Chinese zodiac theme behind the card's name – even including gold-themed PSU cabling. The GPU is slower than an RX 7900 XT, though a bit faster than an RTX 4070.

The rest of the system is very good with a liquid-cooled CPU more than capable of keeping up, and roomy amounts of RAM at 32GB as well as SSD storage at 2TB. The RAM at 5600MHz is below AM5's sweet spot of 6000MHz but given how well-rounded the rest of the system is it's easy to ignore.

CPU: AMD Ryzen 7 7700; **Cooler:** EK Nucleus 360mm Lux AIO; **Motherboard:** Asus TUF Gaming B650-Plus WiFi; **Graphics:** XFX Radeon RX 7900 GRE 16GB; **Memory:** 32GB Geil Polaris AMD Edition RGB C38 5600MHz DDR5 **Storage:** 2TB Crucial P3 Plus PCIe Gen4 NVMe M.2 SSD; **Power Supply:** Corsair RM750e 750W; **Case:** Corsair 3000D RGB Airflow Black.

JW COMPUTERS REAPER

$3,499 | tinyurl.com/APC524JW

If RGB is of no interest to you, this might be a good place to start. This blacked-out system sports a last-gen Intel i7 12700, which is more than up to the task for current games and only slightly behind in productivity compared to 13th Gen. Compared to the similarly priced PLE system this gets a faster RX 7900 XT, but at the cost of having a last-gen CPU and only 1TB of SSD in a DDR4-based platform and a slightly more powerful PSU.

With the more powerful GPU and more productivity-friendly CPU this system has more raw compute on offer – so long as memory bandwidth isn't a concern.

CPU: Intel Core i7 12700; **Cooler:** OEM; **Motherboard:** Gigabyte Z690M A Elite AX DDR4; **Graphics:** Sapphire Radeon RX 7900 XT; **Memory:** 32GB Corsair Vengeance LPX DDR4 3200MHz; **Storage:** Kingston 1TB NV2 PCIe Gen4 SSD; **Power Supply:** 850W; **Case:** Nzxt H5 Flow.

ALLIED COMPUTERS PATRIOT-I

$2,999 – tinyurl.com/APC524AC

The 6-core i5 12400F CPU here is a value champion and is the lowest we'd recommend gaming with if you want a good experience. The RTX 3070 pairing is good though we'd recommend running with higher graphics settings to keep the load off the CPU. The 8GB of VRAM may become an issue at 1440p or higher sooner than hoped as games become more demanding.

The low-end motherboard chipset and low-power PSU scream of a system trying to keep costs down.

A solid PC, a little dearer than we'd like but that's the nature of the market currently. May feel outdated quicker than you might otherwise hope.

CPU: Intel Core i5 12400F; **Cooler:** Allied Sidewinder ARGB 120mm; **Motherboard:** Intel H610 based; **Graphics:** Nvidia GeForce RTX 3070 8GB; **Memory:** 16GB 3200MHz DDR4; **Storage:** 1TB Gen 4 NVMe M.2 SSD; **Power Supply:** 650W; **Case:** Allied Patriot 6-Fan RGB Case.

CPL ONLINE WHITEOUT

$2,759 |tinyurl.com/APC524AC

Compared to the Allied system, the price here feels much better for the class of GPU included, however it comes at the cost of a three-generation old CPU and a smaller 500GB SSD. While the SSD isn't too egregious, the CPU is, and will be the main bottleneck in this system. You could drop in an 11th Gen CPU later, but that'd be wasting money at that point.

As a cheap way to get a system with mid-tier GPU grunt this is certainly worth considering, just know that the underlying platform is EOL and will limit future upgradability.

CPU: Intel Core i5-10600; **Cooler:** OEM; **Motherboard:** Asus ROG Strix B560-A Gaming WIFI; **Graphics:** Asus ROG Strix GeForce RTX 3070 OC Edition 8GB LHR White; **Memory:** 16GB Corsair Vengeance RGB PRO DDR4 3200MHz White; **Storage:** 500GB Corsair Force MP600 NVMe PCIex4 Gen4 SSD; **Power Supply:** Nzxt C750 750W; **Case:** Nzxt H510 White.

PC BUILDER

Blueprints

Value- and performance-driven hypothetical builds

BUDGET

A perfect balance between price and performance.

Each month we try to reduce the overall price points of our builds. Thankfully, time is on our side, and plays an important role here. As the year continues, more sales are popping up while the current-gen gear increases with age. The cycle will inevitably repeat itself, but for now, we find ourselves being able to pick up the latest generation of components at reasonable prices. Retracting from our statement slightly already, we are keeping DDR4 RAM in the budget systems. This is due to our motherboard choices: these are powerful enough for these budget PCs, but bring our costs down significantly compared to using DDR5 RAM and compatible motherboards.

We brought the PNY XLR8 Gaming Epic-X RGB 16 GB DDR4-3600 in a few issues ago, and it remains in both the Intel and AMD machines due to its good performance and price.

Another key component of our Intel build was the Intel Core i3-13100F. It's an admirable brain for the build, and remains here too, though $10 more expensive than before. A price decrease can be found when we look at our GPU, the Intel Limited Edition Arc A750 8GB. Previously $369, it's now on sale at $339. Nothing else changes on our Intel budget build; these sales bring our overall price from $1,254 to $1,224.

Finally, we saw a $10 fall in the price of our Corsair 4000D Airflow case. At $149, it's probably the single component in both builds that could see a much cheaper item in its place. You could score a reasonable case for half this price, but we believe in the quality of this Corsair so it stays.

Over on AMD, our Radeon 6600 XT GPU is now almost impossible to find. So we're switching back to the still decent standard non-XT Radeon 6600. As for the CPU, we've stuck with the AMD Ryzen 5 5600. Nothing changes on the AMD budget build, but the price has now fallen from $1,234 to $1,184, largely due to the change in graphics cards.

AMD INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$149
PSU	Thermaltake Litepower Gen2 450W	$55
Mobo	MSI B550M PRO-VDH WIFI Micro ATX AM4 Motherboard	$179
CPU	AMD Ryzen 5 5600	$199
GPU	Asus Radeon RX 6600 Dual V2 8GB NEW	$319
RAM	16GB (2 x 8GB) PNY XLR8 Gaming EPIC-X RGB DDR4 @ 3600MHz	$89
SSD	500GB Corsair MP600 PRO NH PCIe 4.0 M.2 SSD	$65
HDD	2TB Seagate Barracuda Compute 7200	$69
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$1,184

INTEL INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$149
PSU	Thermaltake Litepower Gen2 450W	$55
Mobo	Asrock B660M Pro RS Micro ATX GA1700	$219
CPU	Intel Core i3-13100F	$179
GPU	Intel Limited Edition Arc A750 8GB	$339
RAM	16GB (2 x 8GB) PNY XLR8 Gaming Epic-X RGB DDR4 @ 3600MHz	$89
SSD	500GB Corsair MP600 PRO NH PCIe 4.0 M.2 SSD	$65
HDD	2TB Seagate Barracuda Compute 7200	$69
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$1,224

"We kept the same motherboards to house all our components. Though we have upgraded the Gigabyte Z790 board in the Intel build from the AC to AX model, for better networking."

MID-RANGE

A game-ready machine that can also handle demanding work.

For our Mid-range machines, our budget (or shall we say, virtual budget) increases to allow us to enter QHD gaming, with enough punch for a powerful system. In fact, for most cases, these builds offer more than enough oomph to get through the majority of tasks, games, and creative work.

On team Intel, we have one of our favourite chips, the Core i5-12600K. It is still a fantastic productivity and gaming CPU, comes in at a great price, and can be overclocked well enough to exhaust more power than it already holds. Although it's not as impressive as its successor, we'll keep it here, as it's also $110 cheaper.

As for the AMD Mid-range build, that maintains the Ryzen 5 7600X. It's a very comparable chip to the i5-12600K, both in performance and price. Both are fantastic brains for your builds, so these stay firmly in place.

What changes have we made to the GPUs on both systems? On AMD, out goes the Gigabyte Radeon RX 6750 XT Gaming OC 12GB, and in comes the Asus Radeon RX 6750 XT Dual OC 12GB. This is purely to save some money, as the latter can be picked up for $589 – $10 less than the previous Gigabyte GPU. As for Intel, we kept the Gigabyte GeForce RTX 4060 Ti Eagle 8GB, after seeing its price fall from $669 to $649. This saves us $20. Not a large saving, but a saving nonetheless. This Gigabyte card is also one of the most competitively-priced 4060 Ti cards on the market.

We kept the same motherboards to house all our components. Though we have upgraded the Gigabyte Z790 board in the Intel build from the AC to AX model, for better networking. This includes the newly added Asrock B650M PG Riptide Wi-Fi Micro ATX to the AMD build – with no price changes, we didn't see it fit to replace either. The same applies to the SSD/RAM combos for both machines. Overall, the AMD machine saw a saving of $61. The Intel build didn't get quite the same price cut – only $41 – but its final price tag is a sweeter $2,215.

AMD INGREDIENTS

Part		Price
Case	Nzxt H7 Flow	$199
PSU	750W EVGA 750 BP 80+ Bronze	$94
Mobo	Asrock B650M PG Riptide Wi-Fi Micro ATX AM5	$269
CPU	AMD Ryzen 5 7600X	$389
Cooler	MSI MAG Coreliquid 240R V2	$129
GPU	Asus Radeon RX 6750 XT Dual OC 12GB NEW	$589
RAM	32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz	$159
SSD	1TB PNY CS3140 NVME M.2 PCIe 4.0 SSD	$99
HDD	2TB Seagate Barracuda Compute 7200	$69
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,056

INTEL INGREDIENTS

Part		Price
Case	Nzxt H7 Flow	$199
PSU	750W EVGA 750 BP 80+ Bronze	$94
Mobo	Gigabyte Z790 UD AX ATX LGA 1700 NEW	$349
CPU	Intel Core i5-12600K	$389
Cooler	MSI MAG Coreliquid 240R V2	$129
GPU	Gigabyte GeForce RTX 4060 Ti Eagle 8GB	$649
RAM	32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz	$159
SSD	1TB Corsair MP600 PRO NH M.2 PCIe 4.0	$118
HDD	2TB Seagate Barracuda Compute 7200	$69
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,215

"Sure, a high price tag is inevitable here, but we do try to keep a beady eye on where we can save some money if possible."

TURBO

The maximum PC.

It's time to open up the throttle on a wide and empty road and let our machines roar to full capacity in the Turbo section. Here, we can allow our imaginations to take flight and create two fantastic PCs both for team Intel and team AMD. Sure, a high price tag is inevitable here, but we do try to keep a beady eye on where we can save some money if possible. The main costs in these builds are typically the GPUs, with the CPUs following behind.

Kicking things off, we made a GPU change on the Intel machine, replacing the Zotac GeForce RTX 4090 Gaming AMP Extreme AIRO 24GB with the Zotac Gaming Trinity OC GeForce RTX 4090 24GB. The former costs $2,799, so to save some money and not sacrifice performance, we brought in the Gaming Trinity OC variant at $2,699.

We applied the same method of thinking on the AMD machine by replacing that GPU for a cheaper card with the same GPU, so out goes the Asrock Phantom Gaming OC Radeon RX 7900 XTX 24GB and in goes a Gigabyte Radeon RX 7900 XTX Gaming OC 24GB, being thecheapest 7900 XTX card we could find. For under $1,600 it's the best AMD offers at the moment, and will certainly provide you with a high-end 4K gaming experience. To keep the system and the monstrous AMD Ryzen 9 7950X3D cool, we've swapped out the Elite version of the Nzxt Kraken X73 for a cheaper variant, as it offers the same cooling capabilities, while also having a more impressive display. We also took that cooler and brought it over to the Intel machine to keep the i9-13900K cool.

As with our Mid-range build, we've upgraded the Intel motherboard from the AC to AX model (Gigabyte Z790 UD AX ATX LGA 1700), for better Wi-Fi performance.

Another component that we've shared across the board was the WD Black SN850X. We've upgraded the capacity of this to 2TB, as this is currently $309 – a brilliant choice for a primary SSD at this price range. Our overall prices of the AMD and Intel Turbo builds both decreased. The final price tag for the AMD comes in at $4,902. For the Intel behemoth, the final price is now $5,681 from $5,643. It brings both machines closer in price – it's just the huge difference between the RTX 4090 and the Radeon RX 7900XTX that keeps the divide there.

AMD INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$299
PSU	1000W Nzxt C1000 80+ Gold	$224
Mobo	Asrock X670E PG Lightning ATX AM5	$539
CPU	AMD Ryzen 9 7950X3D	$1,085
Cooler	Nzxt Kraken X73 RGB 360mm NEW	$329
GPU	Gigabyte Radeon RX 7900 XTX Gaming OC 24GB NEW	$1,599
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$279
SSD	2TB WD Black SN850X M.2 PCIe 4.0 NEW	$309
HDD	6TB WD Blue 5400 HDD	$179
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$4,902

INTEL INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$299
PSU	1000W Corsair RM1000x Shift 80+ Gold	$289
Mobo	Gigabyte Z790 UD AX ATX LGA 1700 NEW	$349
CPU	Intel Core i9-13900K	$889
Cooler	Nzxt Kraken X73 RGB 360mm NEW	$329
GPU	Zotac GeForce RTX 4090 Gaming Trinity OC 24GB NEW	$2,699
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$279
SSD	2TB WD Black SN850X M.2 PCIe 4.0 NEW	$309
HDD	6TB WD Blue 5400 HDD	$179
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$5,681

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QUICK TIPS

The problem solvers

The APC team field problems across the spectrum of devices and software. Learn a new trick or fix you can use.

Safe mode networking

I want to perform a full security scan in Safe mode to be sure that there isn't something nasty buried in my system (nothing shows up in normal mode, but I'm not convinced). I want to boot into Safe mode with networking so I can update all my scanners, but while I did this with no problems a few years ago, I'm now unable to access the internet after rebooting into Safe mode via msconfig using the 'Safe boot' check box with Network selected.

I checked my network adapter (Realtek PCIe GbE Family Controller) in Device Manager, and it has thrown up the following error: "The driver was not loaded because the system is booting into Safe mode." I've never seen this error before, and updating the driver has had no effect. Is this a sign of possible infection?

Bruno Casas

APC responds: No, it's not. What's happening is that some of the very latest network drivers haven't been written to accommodate Safe mode, so won't work even when you choose networking when booting into Safe mode. Thankfully, there is a solution you can apply from within Safe mode – choose a different, albeit older, driver. Navigate to the Driver tab of your adapter under Device Manager and click 'Update Driver' as before, but this time choose 'Browse my computer for drivers', followed by 'Let me pick from a list of available drivers on my computer'.

You'll be presented with a list of matching drivers – the one you want is 'Realtek(R) PCI(e) Ethernet Controller', which dates from 2015. Click Next to install it, and you should see the exclamation mark vanish from Device Manager to indicate that this driver works in Safe mode. Better still, you'll regain internet access.

When you next boot back into Windows, repeat the process to restore the driver to the latest version. The only difference is that this time, you should leave 'Search automatically for drivers' selected to have Windows reapply the latest version.

Toner doesn't show

After seeing the jaw-dropping price difference between original and compatible toner cartridges for my Brother printer, I purchased a compatible toner from a reputable supplier, which until recently worked flawlessly. When I came to switch on the printer, however, I was greeted by a 'No toner' error message, even though when I last looked there was 90 percent of toner left.

I've tried all the recommended fixes: removing and reinstalling the cartridge, checking the contacts on the toner chip, and so on. I've done some research, and have no memory of applying any firmware updates. If I swap the cartridge for my original Brother cartridge, which I still have (but is now empty), it recognises the cartridge, but swapping back doesn't work. Any ideas?

Larry C Bowles

APC responds: This behavior has been known to occur after a power outage, and Larry confirmed that he'd suffered a brief outage a few hours before discovering the problem with his printer. It appears the power failure has fried the cartridge's chip, so it no longer functions. Luckily, he has the original cartridge with a genuine Brother chip, and it's easy to swap out the chips, allowing him to fix the chip from the original cartridge to the new one.

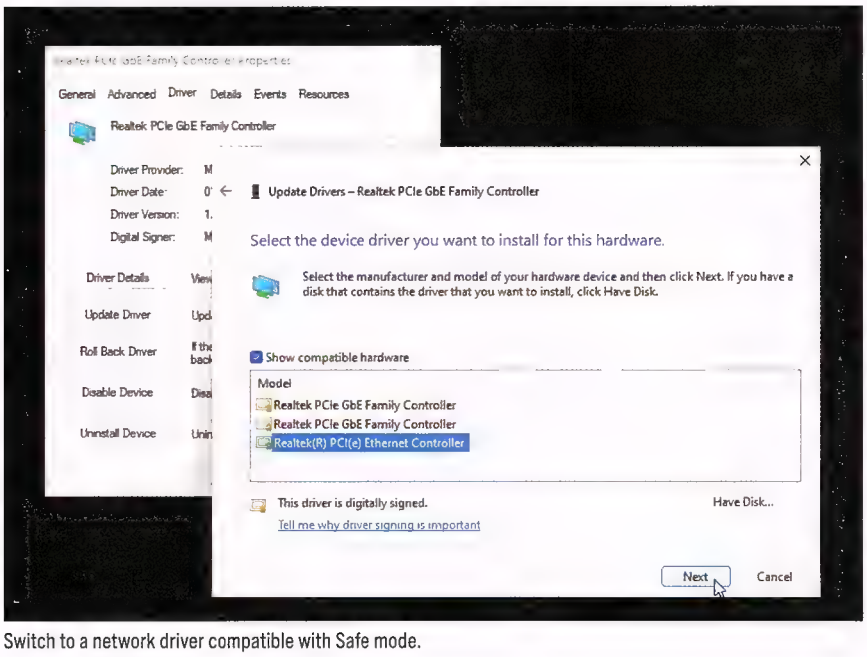
It's a relatively simple task: you need a small flat-bladed screwdriver to lever the two chips out of their cartridges – they bear a superficial resemblance to a mobile phone SIM card, and you'll find them on the right-hand side of the cartridge when it's flipped over. Neither is screwed into place, so ease each one out using the screwdriver, then swap them over, making sure the contacts are facing up.

Once he'd performed this step, Larry was able to report that the toner cartridge worked again. If for any reason the cartridge is recognised but now claims to be empty, you can reset the counter via your Brother's control panel. The exact steps vary by model – Google your printer model and the words "toner reset" to track down instructions.

Back up Android

I'm a long-time reader/subscriber of both the print and digital editions. I took your advice several years to build a back-up solution for three PCs using the paid edition of Macrium Reflect, running weekly full backups and daily differential backups to a NAS. This has allowed me to recover from several catastrophic hardware failures quickly and easily, and to clone systems to new hardware. Macrium makes it easy to 'mount' a backup to recover individual files as well. It's a great solution.

Now, I want the same thing for my two Samsung Galaxy smartphones. However, I can't find anything remotely



Switch to a network driver compatible with Safe mode.

like Macrium Reflect for Android. I've contacted Macrium, and it has no plans to address this requirement. Acronis claims to have a solution for Android, but it failed repeatedly when I tested it over my in-house Wi-Fi. The other 'backup' apps seem to focus on syncing specific file types to a cloud server, which is not what I'm looking for.

Why is this so easy for Windows and so hard for Android?
Brad Grigor

APC responds: There are several stumbling blocks that make taking a complete backup of Android phones impossible, not least the fact that they'd need to be rooted, as well as the impractical nature of backing up a system over Wi-Fi on a phone running on batteries.

You'll need to limit yourself to a two-stage back-up plan: the first continues to back up your key data and settings over the cloud using Google's built-in option. The second involves regularly connecting your phone to your PC using a USB cable, enabling USB debugging mode, then employing one of two options.

The simplest option is a tool like Dr Fone from **https://drfone.wondershare.com** (scroll down and click Android Backup under Phone Backup). You can back up your phone for free, but should you need to restore your backup, you'll need purchase Dr Fone Basic, which costs US$49.95. Dr Fone can back up 11 types of data from your phone, from photos and videos to applications (including all app data), call history, messages, and contacts. It's simple to set up and use, and you'll have a single compressed back-up file on your PC, which Dr Phone Basic can restore not just to your current phone, but a newer model too.

> "Some of the very latest network drivers haven't been written to accommodate Safe mode, so won't work even when you choose networking when booting into Safe mode."

Alternatively, you could install Android Studio on your PC, which includes a copy of the Android SDK platform. This contains a tool – adb – which can back up system files, as well as application data (and optionally, applications), but it doesn't include the other items covered by Dr Fone Basic. Visit **https://forum.xda-developers.com/t/guide-full-phone-backup-without-unlock-or-root.1420351** for a guide to using it once you've installed the full version of Android Studio (**https://developer.android.com/studio**). Uncheck 'Android Virtual Device' during setup. Once installed, open Android Studio, which will run you through another setup wizard. When prompted for the components to install, uncheck everything except 'Android SDK' at the top.

Once in place, with your phone connected, close the main Android Studio window, right-click Start, and choose Terminal (Admin). Issue the following commands:

```
cd AppData\Local\Android\sdk\platform-tools
```

You can now run the adb command (it needs to be prefixed with .\ in order to work) – for example, the following backs up system and app data to your D drive:

```
.\adb backup -all -f D:\android-backup.ab
```

Should you ever need to restore the backup:

```
.\adb restore D:\android-backup.ab
```

It's not as comprehensive as Dr Fone, and the feature has already been depreciated, so APC suggests giving Dr Fone a try and seeing how you get on.

Try swapping toner cartridge chips to fix 'no toner' errors.

Clean up Batocera

I loved your feature on creating your own gaming PC, and have set up Batocera on a USB stick so I can play classic games at home and relive old favourites. My only niggle so far is that several games come on more than one disk, so appear multiple times on the game-list screens. Is there a way to merge – or at least hide – the other disks?
Jessie Rust

APC responds: There's no one-size-fits-all approach, but broadly speaking it involves creating M3U playlist files for those systems that support it – we tested them successfully with Atari ST, Amiga, and several console platforms, but it didn't work with the ZX Spectrum.

Thankfully, you can create m3u (and other text) files from within Batocera. Press F1 to open Batocera's File Manager (PCManFM). Open Roms and navigate to the directory containing your multi-disk game. Now, right-click inside this folder and choose Create New... > Empty File. Name it <game title>.m3u, substituting <game title> with your choice of game – for example, Civilization.m3u.

Make a note of each disk's filename. Double-click the m3u file you created and populate it with the names of each disk like so:

```
Game Title (Disk 1).adf
Game Title (Disk 2).adf
```

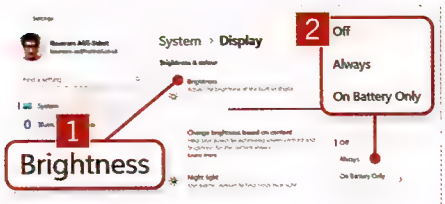
Choose File > Save followed by File > Quit. Press Ctrl-Q to return to the main Batocera window, press the Space key and choose Game Settings > Update Gamelists. After the rescan completes, you should see the multiple disk entries are replaced by a single entry you can now scrape with metadata like any other.

Depending on the platform you're creating playlists for, they may automatically load all the disks in the correct order; otherwise you'll need to continue swapping disks manually. For more information check the Batocera wiki (**https://wiki.batocera.org/cd_image_formats**). ■

WINDOWS

Make Windows better

Expert tips for a better experience.



WINDOWS 11

Turn adaptive brightness settings on or off

Microsoft's third 'Moment' update for Windows 11 added the adaptive brightness setting for desktop PCs (it was previously available only for laptops). When active, it automatically changes the brightness level of your screen based on what's being shown. If you're watching a dark scene in a film, for example, the screen will automatically dim. While it might be useful for preserving battery on a laptop, you might want to turn it off completely, or even set it so it's always on.

To change the feature, first right-click anywhere on your desktop and select 'Display settings'. Click the Brightness setting (1 in our screenshot below), then the dropdown menu next to 'Change brightness based on content'. By default, it's turned to Off for desktop PCs and set to On Battery Only for laptops 2. Click 'Always' to use adaptive brightness at all times, or Off to disable it.

If you can't see these options, check whether you can install the Moment 3 update, which is now available for everyone. Press Windows key-I to open Settings, then click Windows Update followed by the blue 'Check for updates' button. Look for the update KB5027231, then follow the installation process. It updates you to build 22621.1848 of Windows 11.

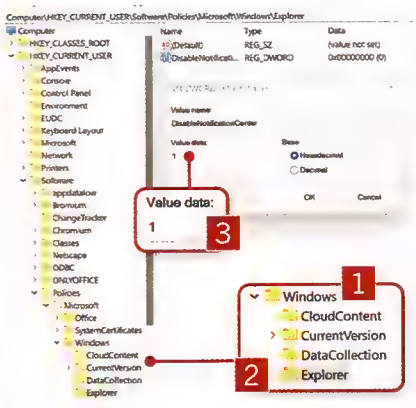
WINDOWS 10 & 11

Remove the Action Centre

The Action Centre shows messages from Microsoft including notifications telling you you're near a Wi-Fi network and reminders that you have emails to read. You can see these by clicking the square speech-bubble icon at the bottom right of your screen.

You can snooze or clear these notifications at any time, but if you have no need for them you can remove the Action Centre by tweaking the registry.

First, type regedit into the Start menu, then click the Registry Editor app to open it. On the left-hand pane, click HKEY_CURRENT_USER to open a list of options, then click Software, Policies, followed by Microsoft. Right-click the Windows option (1 in our screenshot above), then click New, followed by Key. Type Explorer to name the key you've just created. Now right-click the Explorer folder 2, then click New, followed by 'DWORD (32-bit) Value'. Type DisableNotificationCenter to name this value, then press Enter. Double-click this value and change the value to 1 3. Click OK to confirm. Now restart your computer and the Action Centre will be disabled.

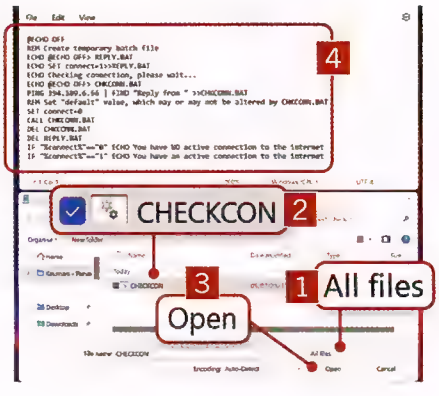


WINDOWS 10 & 11

Check what's in a batch file before running it

Batch files – which have the file extension .bat – are scripts that execute several commands at once, rather than requiring you to enter them into Command Prompt one by one. They add extra functionality in Windows, such as letting you open multiple programs at once. You can find pre-written batch files online, but downloading and running them can be risky if you don't trust the source. To stay safe, you should preview batch files in Notepad to see what commands they will run.

Search for and open Notepad in Windows. Now click File, Open, then navigate to your batch file – it will probably be in the Downloads folder if you've found it online. Click the File Type dropdown menu and choose 'All files' (1 in our screenshot below). By default, this will be set to 'Text documents (*.txt)' and will not detect .bat files. Next, select your file. Our example file 'CHECKCON' 2 is a script that checks whether you are connected to the internet or not. Click Open 3 and you'll see all the commands your batch file will run 4 when you execute it.

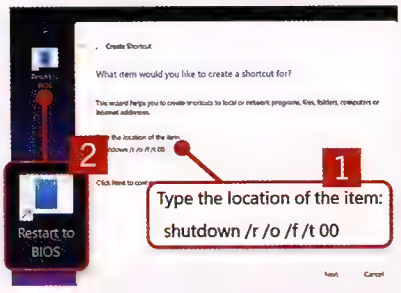


WINDOWS 10 & 11

CREATE A SHORTCUT TO BOOT INTO BIOS

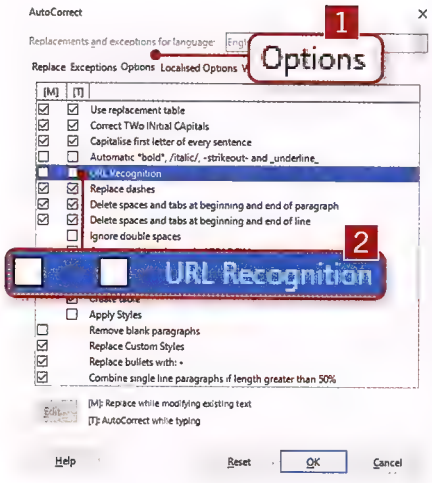
Accessing your PC's BIOS menu lets you perform several useful functions, such as running hardware tests, and also shows vital information about your system. Normally you have to restart your device and tap a key on startup, such as F10 or F12 (though it varies from one machine to another). A much easier way to access your BIOS menu is by creating a desktop shortcut.

Right-click anywhere on the desktop, then click New, followed by Shortcut. Now type shutdown /r /o /f /t 00 into 'Type the location of the item:' (1 in our screenshot) then click Next. Now type Restart to BIOS in the 'Type a name for this shortcut' box. Click Finish. You can now double-click the shortcut 2 to reboot your PC into the BIOS menu.



Make Office better

Top tips for the best office programs



LIBREOFFICE WRITER & MICROSOFT WORD

Stop URLs and email addresses being hyperlinked

Both LibreOffice Writer and Microsoft Word turn web and email addresses into hyperlinks when you type them. If you don't want this to happen it's easy to turn it off.

In Writer, click the Tools tab on the toolbar, then Autocorrect, followed by Autocorrect Options. Now click the Options tab (1 in our screenshot above) and, under both the [M] and [T] columns, untick URL Recognition 2. Click OK. The next time you type an email or web address, it won't be turned into a hyperlink.

Change this setting in Word by clicking File, then Options. Select the Proofing tab, then click AutoCorrect Options. Now select the AutoFormat tab and untick 'Internet and network paths with hyperlinks'. Click OK, then OK again.

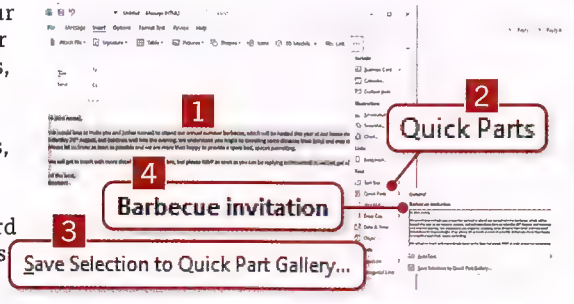
MICROSOFT OUTLOOK

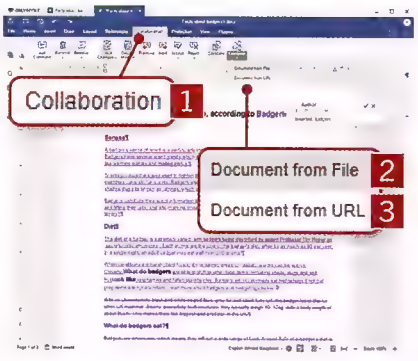
Create a quick email template

Sending the same email to several people can feel impersonal, but rewriting it for each recipient can take time. Outlook's Quick Parts solves this conundrum by letting you save blocks of texts as templates that you can paste into emails. You can then tweak this text to create a message that's more relevant to the recipient.

In Outlook, click New Email, begin drafting your message, then highlight the text you want to save to Quick Parts (1 in screenshot below). Click the 'More commands' button (three dots), then click Quick Parts 2. From the options that appear, click 'Save Selection to Quick Part Gallery' 3.

When the Create New Building Block box appears, give the template a name and description – we've called it 'Barbecue invitation' 4. Click the block of text to add it to your email.





ONLYOFFICE

Combine two documents into a new one

With OnlyOffice version 7.4, released 13 June, you can merge two documents to form a new one. First, open your original document and, in the Collaboration tab (1 in our screenshot above), click the Combine dropdown menu. Select 'Document from File' 2, then browse File Explorer to import your second document. You can also import a document from the web by clicking 'Document from URL' 3.

Any differences between the documents will be crossed through – simply click the small X in the box on the right to 'accept' the difference. You can now edit the document.

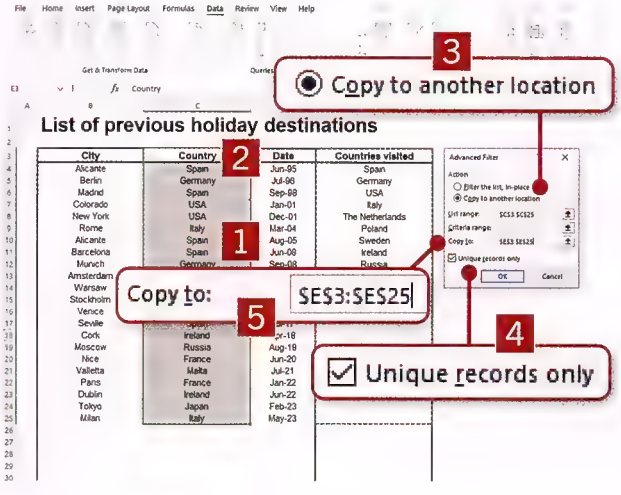
You can install OnlyOffice 7.4 from **tinyurl.com/APC52400**, or by clicking About at the bottom left of the main OnlyOffice page and selecting 'Check for updates'. To get updated automatically in future, click Settings (just above About) then select Enabled in the 'Check for updates automatically' dropdown menu.

MICROSOFT EXCEL

Copy unique values from one column to another

In Excel, you can filter unique values (ie, those that appear only once) in a list and copy them to a different column. In our example, the countries we've previously visited on holiday are listed in column C (1 in our screenshot), but there are many repeats.

To filter the unique values, first highlight the full range – it's C3:C25 in our example – and the heading ('Country') 2. Next, click the Data tab at the top followed by Advanced in the 'Sort & Filter' section. When the Advanced Filter box appears, select 'Copy to another location' 3, then tick 'Unique records only' 4. Next, click the button next to the 'Copy to:' field and choose which cells you want the unique results to appear in (E3:E31 in our case 5). Note, the $ signs display by default in any selection – you don't need to enter these yourself. Finally, click OK. In our case, all unique countries in column C now appeared in column E, including the label 'Country'. We changed the Country heading in E3 to 'Countries visited' afterward to differentiate the two columns. ■



ONLINE

Browser tips

Secret settings and best extensions

CHROME

Read web pages without the clutter

Chrome 115, released 18 July, finally introduces the browser's long-awaited 'Reading mode' . This converts the web page you're viewing into a more readable format by removing all the adverts, images, design elements and other clutter.

To use the new feature, click the 'Show side panel' button on Chrome's toolbar (1 in our screenshot below) and select 'Reading mode' in the dropdown menu 2. The cleaned-up text from the current page will now be displayed in the side panel.

Resize the panel by dragging its border to the left, then use the options on the toolbar to customise how the content looks. You can change the font, make the text larger or smaller, apply a dark or colour theme, and adjust the line height and letter spacing.

If you can't see the new 'Reading mode' option or you're still waiting for Chrome to update to version 115, type chrome://flags in the browser's address bar and press Enter to load the Experiments page. Find the entry Reading Mode, select Enabled in its dropdown menu and relaunch Chrome.

FIREFOX

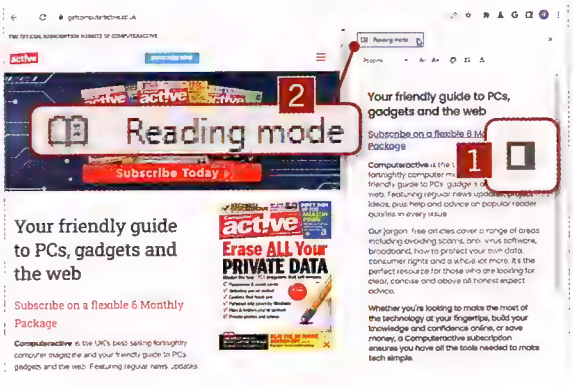
Translate foreign text without an extension

Firefox 115, which was released at the beginning of July, brings the browser in line with Chrome and Edge by adding the option to translate foreign-language web pages into English. Previously, you needed to install Mozilla's Firefox Translations extension, but now the feature is built in.

When you're viewing a foreign website, click the new 'Translate this page' icon at the end of the address bar (1 in our screenshot above right). Firefox should automatically detect the language of the page, but if not, you can choose it in the 'Translate from' dropdown menu. Ensure 'English' is selected as the 'Translate to' language, then click Translate 2 to convert the content.

To make Firefox translate pages in that language automatically, click the cog in the top-right corner of the Translate box and choose 'Always translate [language]'. The feature currently supports 18 languages, including French, German, Italian, Norwegian, Portuguese, Spanish and Ukrainian.

If you can't see the 'Translate this page' icon, type about:config into Firefox's address bar, press Enter and click 'Accept the Risk and Continue'. Search for the browser.translations.enable preference and double-click it to change its value to 'true'. To enable automatic translation, do the same for the browser.translations.autoTranslate preference.

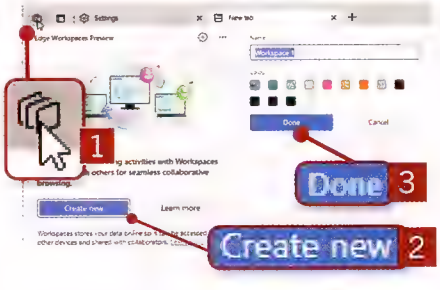


EDGE

Collaborate on projects using Workspaces

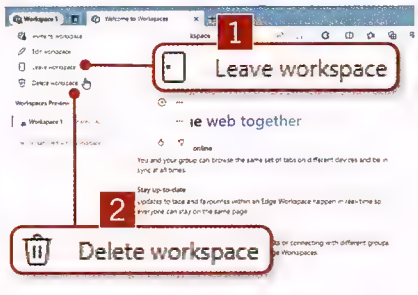
When Microsoft updated Edge to version 114 in June, it added yet

CREATE A SHARED WORKSPACE IN EDGE



1 To create a workspace, sign into your Microsoft account, then click the new 'Workspaces menu' button 1 in the top-left corner of the browser. Click 'Create new' 2, enter a name for your workspace and assign it a colour, then click Done 3.

2 When your new workspace opens, click the Invite button 1 to ask people to join. Click 'Copy link' 2 to copy the invite link to your clipboard, then paste it into an email. Microsoft currently limits you to five invites across all your workspaces.



3 Any tabs you open in your workspace will be visible to other members, so you can collaborate on projects in real time. Once the work is finished, click the 'Workspaces menu' and either choose 'Leave workspace' 1 or 'Delete workspace' 2.

BEST EXTENSION FOR...
Hiding distractions on YouTube

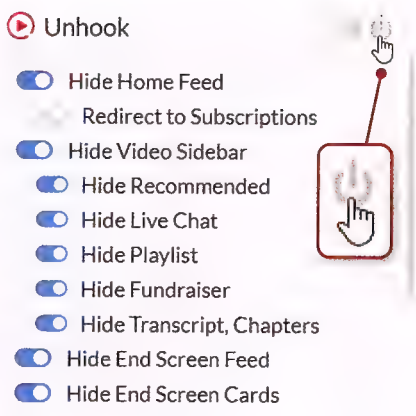
UNHOOK
Chromium tinyurl.com/APC524unch
Firefox tinyurl.com/APC524unff
Edge tinyurl.com/APC524uned

Ever wish you could watch videos on YouTube without being distracted by recommendations, user comments, live-chat boxes, trending content and all the other elements that draw your eyes from what you're viewing?

Unhook provides a simple solution by letting you hide everything that annoys you on YouTube – except ads, for which you'll need a separate ad-blocking extension.

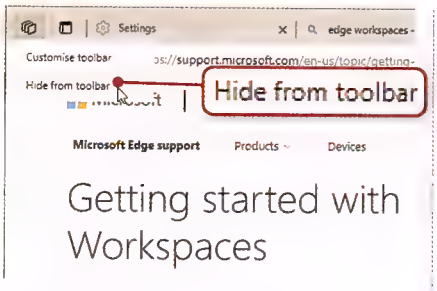
Click its toolbar button then click the power button (see screenshot) to turn on the extension, then configure its settings to disable specific distractions – or remove the entire Home feed and video sidebar.

You can also hide the cards that appear at the end of videos, stop the next clip playing automatically, disable annotations and much more. Switch on Unhook's dark mode when you're watching YouTube at night.



If you don't like that, try...
Remove YouTube Suggestions
tinyurl.com/APC524rem

Designed to "make YouTube less engaging", this extension lets you hide video recommendations across the site between specific times of the day.



another feature – Workspaces – to the increasingly bloated browser. This allows you to collaborate on projects with friends, family and colleagues in real time, by creating a shared window – or 'workspace'.

Within this workspace, you can view the same websites, work on documents together and share files more easily than emailing them back and forth. Workspaces was originally designed for businesses, but Edge 114 makes it available to home users too. See our Workshop below left to learn how to use the feature.

If you're not interested in Workspaces, right-click its three-screen icon in the top-left corner of Edge and choose 'Hide from toolbar' (see screenshot above).

BRAVE
Extract text from online images

Some images you see online contain useful or interesting information that isn't replicated elsewhere on the web page – for example, photos of menus and signs or screenshots of messages. Because you can't copy and paste this content, you need to type it manually if you want to save it for personal use.

To solve this problem, Brave 1.52 (released in June) added a handy option to extract text from images so you can use it elsewhere. Simply right-click an image on a web page and choose 'Copy text from image' (see screenshot above). Brave will tell you the text that it's copied, which you can then paste into a document or email by pressing Ctrl-V.

The feature isn't perfect – we found that it doesn't always extract all of the text from an image or gets some words wrong. But Brave helpfully removes the formatting from copied content to give you a clean paste.

You can copy text from images in other Chromium browsers by installing the extension Copyfish (**www.snipca.com/46581**), which also works with videos and PDFs.

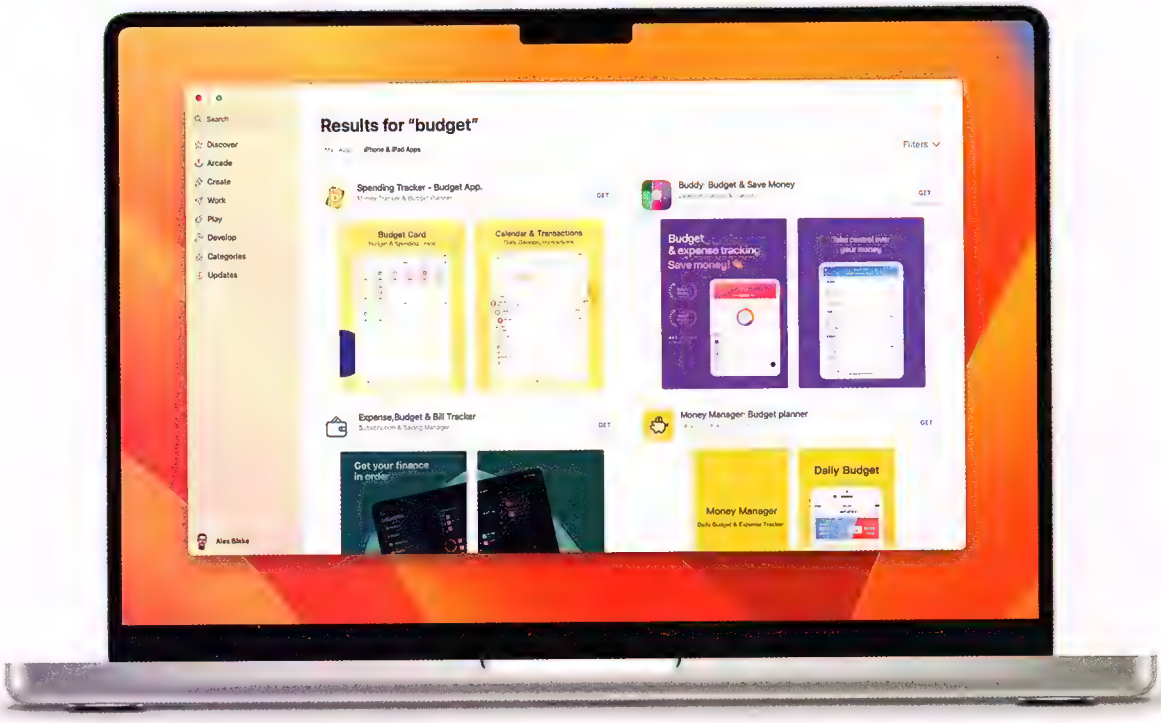
CHROMIUM
Add an AI shopping assistant to Amazon

Amazon Guru AI (**tinyurl.com/APC524amazai**) uses AI to provide useful information about items on Amazon. Rather than scroll through a product page to find specific details or decide whether it's worth buying, click the orange chat button (see screenshot below) to launch the chatbot and get it to do the hard work for you.

Ask Amazon Guru about a particular aspect of the product, such as its size, or to summarise the customer reviews, and the 'shopping assistant' will quickly respond with a helpful answer. It's not so good at providing price and delivery information, but it works on any Amazon store.

Because Amazon Guru is a new extension, Chrome may warn you that it's "not trusted by Enhanced Safe Browsing", but this is safe to ignore. It also requires permission to "read and change your data on all Amazon sites" so it can interact with the store – its developer promises that it won't collect any user information.

Amazon Guru
Hello, how may I help you?
Please summarise the customer reviews
The customer reviews for the Introducing Echo Pop speaker are mixed. Some customers are very happy with the sound quality and size of the speaker, while others feel that it is overpriced and has poor sound quality. Some customers recommend waiting for a sale to purchase the speaker. Overall, the reviews suggest that the speaker is a decent option for those looking for a compact smart speaker with Alexa.
How big is it?
Summarize All Reviews



MAC OS

Use mobile apps on macOS

Run iPhone and iPad apps and games on your Apple silicon Mac.

IT WILL TAKE
10 minutes

YOU WILL LEARN
How to download and install iOS and iPadOS apps and games on to your Mac

YOU'LL NEED
An Apple silicon Mac, macOS 11 or later

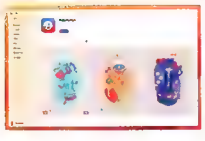
Ever since the first Apple silicon Macs arrived in 2020, they've offered an additional benefit – the ability to run iPhone and iPad apps too with no messy conversion required. That's because devices like your iPhone, iPad, and M1 and M2 Macs effectively run on identical architecture – the major difference being that while Mac apps are designed to be used with a mouse or trackpad and a keyboard, iPhone and iPad apps use touch-based taps, swipes and other gestures.

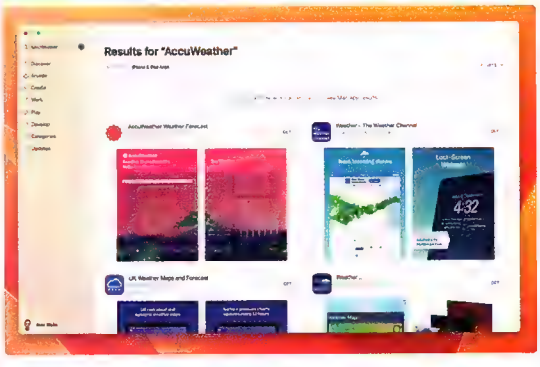
To get around that, macOS has a feature called Touch Alternatives that 'remaps' iPhone and iPad apps so they can be used with your Mac's input devices. This should work with the overwhelming majority of iPhone and iPad apps, but there are exceptions. Developers can, if they wish, explicitly prevent their iPhone and iPad apps from running on Apple silicon – often because they already offer a perfectly good Mac version. For apps that aren't available, try iMazing ($59.99, **imazing.com**). Read on to find out more.

Alex Blake

HOW TO RUN MOBILE APPS ON MAC

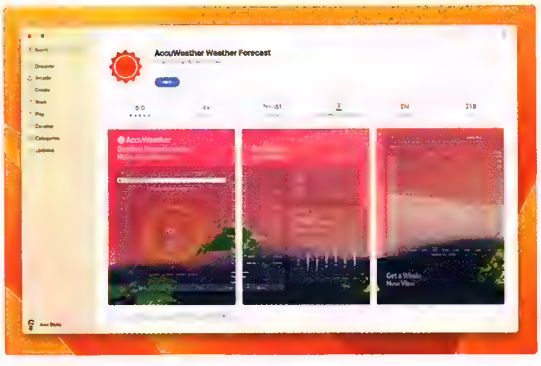
GENIUS TIP!
Some iPad apps say 'Not verified for macOS' in the App Store. They will work, but they haven't been tested on macOS by the developer, so may be a bit buggy.





1 SEARCH THE MAC APP STORE

In the Mac App Store, try searching for an app. On the results page, click the iPhone & iPad Apps tab, then click an app. Under the app's name you will see 'Designed for iPad', indicating that it is an iPadOS app.



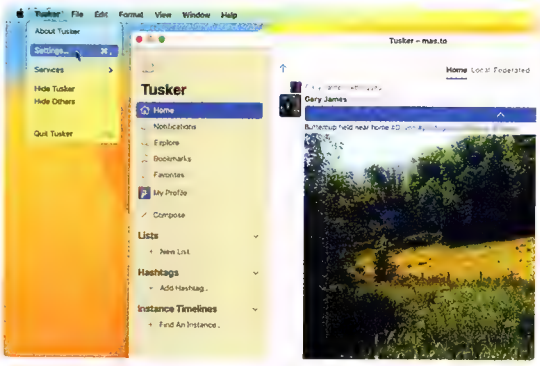
2 GET A NEW APP

You can download the app from here. You don't need to do any additional work, as macOS-compatible iOS and iPadOS apps will simply work straight away once they are downloaded and installed.

CONTINUED... RUN MOBILE APPS ON MAC

3 APPS IN YOUR ACCOUNT

You can also download iOS or iPadOS apps already tied to your iCloud account. Open the Mac App Store and click your account in the bottom left. Under Account, select iPhone & iPad Apps and pick an app to install.



4 TOUCH ALTERNATIVES

Apps for touchscreen devices come with tweaks called Touch Alternatives in order to work on Macs. In the downloaded iPhone or iPad app, click the app's name in the top left, then select Settings > Touch Alternatives > On.

5 NEW CONTROLS

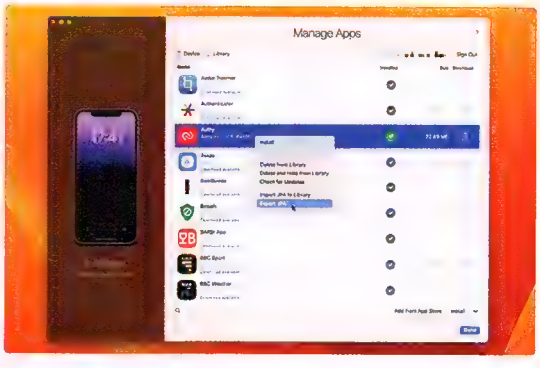
The Touch Alternatives menu shows the controls that let you use gesture-based apps on Mac. You'll see a diagram of your keyboard and mouse or trackpad, with touchscreen swipes and taps mapped to their buttons.

6 GAME OPTIMISATIONS

Games have their own touch alternatives that are better optimised for gaming. Click [App name] > Settings > Game Control to use your keyboard and mouse in place of a controller, tweak pointer sensitivity, and more.

7 MAZING

Some iPad apps aren't available in the Mac App Store, but if they're on your iPhone or iPad you can install them with a Mac app called iMazing. Install iMazing, then connect your unlocked iPhone or iPad to your Mac.



8 EXPORT .IPA

In iMazing, click Manage Apps > Library and click the Download button next to your chosen app. Now Ctrl-click the app and select Export .IPA. Save the file, then open it. This will install and run the app on macOS.

JARGON BUSTER

Touch Alternatives are controls that mimic touch gestures on your Mac, letting you use the arrow keys to swipe left and right, for example.

GENIUS TIP!

Not all iPhone or iPad apps downloaded via iMazing will work on your Mac. You might get an error message, in which case you'll need a replacement app.

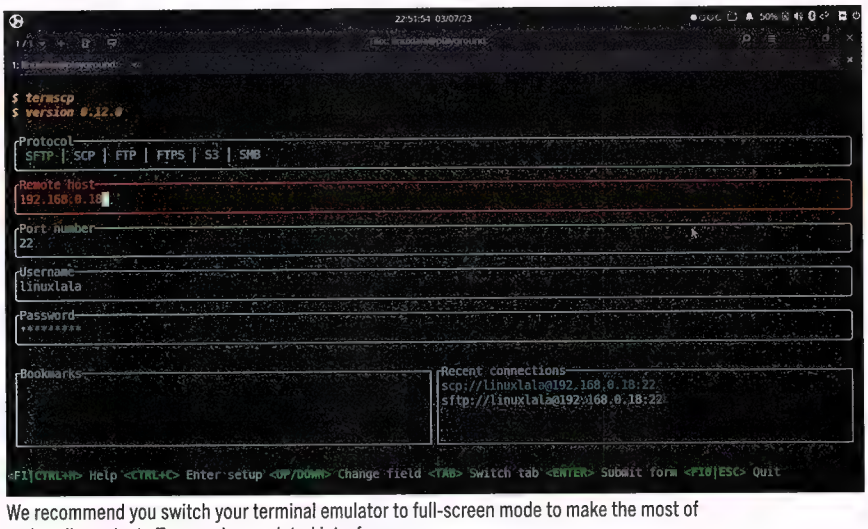
LINUX

Multi-protocol transfer

Shashank 'Proficient With SMB, SSH, SCP and More' Sharma never has to rely on thumb drives to move data across different machines...

Your Linux distro is home to many different file explorer utilities. The graphical desktop environments all feature at least one, and there are even lightweight alternatives if you decide to work only with a window manager to keep the bloat to a minimum. Even the CLI offers plenty of different file managers. But to describe Termscp, our tool of choice, as a mere file explorer is about as accurate as calling the Batmobile just a car.

Termscp describes itself as a feature-rich file transfer and explorer utility that supports SCP, SFTP, FTP, S3 and the SMB protocols. This means that if you have the relevant packages installed and configured, you can use Termscp to not only explore the local and remote machines, but also transfer files, all from the comfort of its paned TUI.



We recommend you switch your terminal emulator to full-screen mode to make the most of and easily navigate Termscp's populated interface.

First steps

Released under the MIT licence, Termscp isn't offered in the software repositories of popular Linux distros. But that's all right because the developer provides a shell script to help you install it. At a minimum, you must ensure that you **apt install** libdbus-1-x, pkg-config and libsmbclient installed on your machine before you proceed to install Termscp using the official shell script:

curl -sSLf http://get-termscp.veeso.dev | sh

This command downloads the installer script using the Curl utility and then executes it. Although this is the officially recommended installation method, the project also offers DEB and RPM binaries for Debian and Fedora-based distros respectively. You'll find the relevant instructions on the project's website (**https://termscp.veeso.dev/#get-started**).

Because the project is written in Rust, it's also possible to install it using Cargo, the package manager for Rust packages. If you don't already have Rust and Cargo installed, you can use your distro's package manager to install these. The **sudo dnf install rust cargo** command installs these on RPM-based distributions, such as Fedora. You can similarly run the **sudo apt install cargo** command, which also installs the Rustc package if you're running Ubuntu or Debian, or one of their derivatives. After installing the three dependencies, you can install Termscp using Cargo with the **cargo install termscp** command.

We've thrown quite a few acronyms in this tutorial, and if you're new to them, this table should help.

Protocol	Complete name	Purpose
SSH	Secure Shell	Network protocol that allows two machines to connect
SCP	Secure Copy	Part of SSH, used for copying files between machines
FTP	File Transfer Protocol	Transfers files across machines
SFTP	Secure FTP	Think FTP + SSH for added security
S3	Amazon Simple Storage Service	Special cloud storage service by Amazon

Using some of these protocols requires additional packages to be installed and configured. At a minimum, you need OpenSSH as well as the openssh-client package on your local and remote machines if you wish to use Termscp to transfer files across machines using SFTP or SCP. Most modern desktop distros such as Ubuntu ship with OpenSSH installed out of the box.

Understanding the interface

If you already know which protocol you wish to use with Termscp, you can launch the utility with the **termscp <protocol>://<ip>:<dir_path>**

OTHER FEATURES

Termscp offers many useful features even if you only wish to use it as a file explorer. For instance, while the file explorer is configured to sort files by name by default, you can easily change this. Press **b** and then choose either Name, Modify Time, Creation Time or Size in the Sort Files By dialog box.

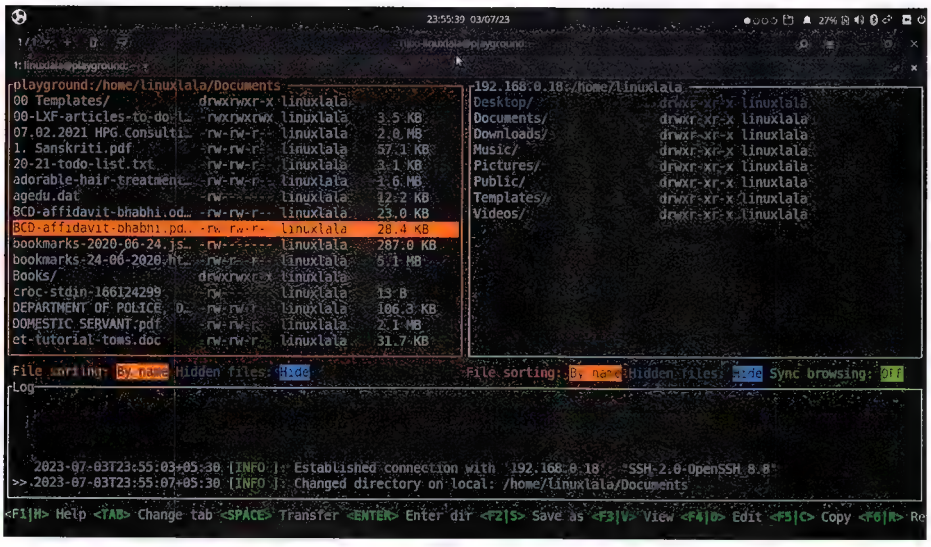
You can similarly press **a** to view hidden files in the currently selected file explorer pane.

Termscp ships with a number of configurable parameters. While the configuration is all handled by a TOML file, you can tweak these parameters from within Termscp itself. The project refers to the screen where you're prompted to select the type of connection you wish to establish as the main screen. From there, press Ctrl-c to access the Configuration interface.

The configurable parameters are split across three different tabs: SSH Keys, Configuration Parameters and Theme. You can switch between them using the tab key.

From the Theme tab, you can set custom colours for various objects within the Termscp interface, such as Username, Password, Recent Connections and so on. When you make any change, press F10 and select either Save, Don't Save or Cancel in the pop-up dialog box.

You can similarly define the default text editor, protocol, whether or not to show hidden files, enable desktop notifications and so on from the Configuration Parameters tab.


playground:/home/linuxlala/Documents
00 Templates/ drwxrwxr-x linuxlala
00-LXF-articles-to-do-l.. -rwxrwxrwx linuxlala 3.5 KB
07.02.2021 HPG Consulti.. -rw-rw-r-- linuxlala 2.0 MB
1. Sanskriti.pdf -rw-rw-r-- linuxlala 57.1 KB
20-21-todo-list.txt -rw-rw-r-- linuxlala 3.1 KB
adorable-hair-treatment.. -rw-rw-r-- linuxlala 1.6 MB
agedu.dat -rw------- linuxlala 12.2 KB
BCD-affidavit-bhabhi.od.. -rw-rw-r-- linuxlala 23.0 KB
BCD-affidavit-bhabhi.pd.. -rw-rw-r-- linuxlala 28.4 KB
bookmarks-2020-06-24.js.. -rw------- linuxlala 287.0 KB
bookmarks-24-06-2020.ht.. -rw-r--r-- linuxlala 5.1 MB
Books/ drwxrwxr-x linuxlala
croc-stdin-166124299 -rw------- linuxlala 13 B
DEPARTMENT OF POLICE D.. -rw-rw-r-- linuxlala 106.3 KB
DOMESTIC SERVANT.pdf -rw-rw-r-- linuxlala 2.1 MB
et-tutorial-toms.doc -rw-rw-r-- linuxlala 31.7 KB
192.168.0.18:/home/linuxlala
Desktop/ drwxr-xr-x linuxlala
Documents/ drwxr-xr-x linuxlala
Downloads/ drwxr-xr-x linuxlala
Music/ drwxr-xr-x linuxlala
Pictures/ drwxr-xr-x linuxlala
Public/ drwxr-xr-x linuxlala
Templates/ drwxr-xr-x linuxlala
Videos/ drwxr-xr-x linuxlala
File sorting: By name Hidden files: Hide
File sorting: By name Hidden files: Hide Sync browsing: Off
Log
2023-07-03T23:55:03+05:30 [INFO]: Established connection with '192.168.0.18' 'SSH-2.0-OpenSSH_8.8'
>>.2023-07-03T23:55:07+05:30 [INFO]: Changed directory on local: /home/linuxlala/Documents
<F1|H> Help <TAB> Change tab <SPACE> Transfer <ENTER> Enter dir <F2|S> Save as <F3|V> View <F4|O> Edit <F5|C> Copy <F6|R> Re

command. For instance, we used **termscp sftp://192.168.0.18:/home/linuxlala** to launch Termscp to use SFTP.

You can alternatively launch Termscp with the **termscp -b** command, which presents the screen as depicted in the first screenshot (above-left). Here, you have the option to select the protocol to use to connect to the remote machine. Use the right and left arrow keys to select the protocol, and the up and down arrow keys to supply the other information, such as IP address, port number, username and password. When you're done, hit Enter.

You'll notice a Recent Connections box on the bottom-right of this Termscp screen. If you don't want to retype the same information again and again when connecting to a previously accessed remote machine, navigate to this box and select the connection you wish to establish again, and hit Enter. This way, instead of typing the IP address, port, username and so on, you're only prompted to enter the password.

After Termscp connects to the remote machine, you'll see the interface as shown in the second screenshot (above). As you can see, the interface is split into two panes at the top. The left pane shows the local machine, while the right pane is reserved for the remote machine.

You can use the right and left arrow keys to move between these two panes. While you can access the supported keybindings by pressing F1, here are some of the most useful ones.

Keybinding	Function
F1	View keybindings
Esc	Disconnect from remote machines
Right/Left	Switch the explorer pane
u/Backspace	Move to parent directory
d/F7	Make directory
e/F8	Delete selected file(s)
F5	Copy selected file(s)
F6	Move selected file(s)
m	Select file – can be used to select multiple files
i	Show info about selected file
Space	Copies the selected file to the current directory of other machine
q	Quit Termscp

The log pane below the file explorer panes is constantly changing and reflects all actions performed on the local and remote machine, such as changing directories, copying, renaming, deleting files and so on.

You'll find a list of commonly used keybindings at the bottom of the interface.

As with any feature-rich TUI, Termscp can take some getting used to. One of the oddest things about it is the help menu (referred to as Quick Help). Another useful feature is the ability to synchronise a file or directory with a remote path, but we couldn't get it to work between our Ubuntu and Fedora machines. ■

Termscp is one of those rare TUIs that make us want to feature more than just a couple of screenshots. There's plenty to see here and almost all of it quite good.

GENIUS TIP!

The keybindings as accessed by pressing F1 are all listed as upper-case letters. This is incorrect. All keybindings, except for the function keys such as F1, F6, F8 and so on, are lower-case. That is, you press d and not D to create a new directory, and e not E to delete the selected file. Also, F6 is for moving files, not renaming them.

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MOBILE DEVICES

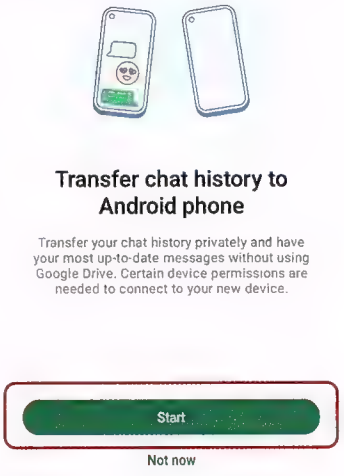
Phone and tablet tips

Brilliant things to do on your device.

ANDROID & iOS

Transfer your WhatsApp chats to a new phone

WhatsApp has made it easier to transfer your chat history to a new phone. Previously, you needed to back up your messages to Google Drive or iCloud, then download them on the new device. Now you can perform the transfer using a QR code, though only if both phones are running the same mobile operating system – you can't use the new method to transfer chats from Android to iOS or vice versa.


Transfer chat history to Android phone
Transfer your chat history privately and have your most up-to-date messages without using Google Drive. Certain device permissions are needed to connect to your new device.
Start
Not now

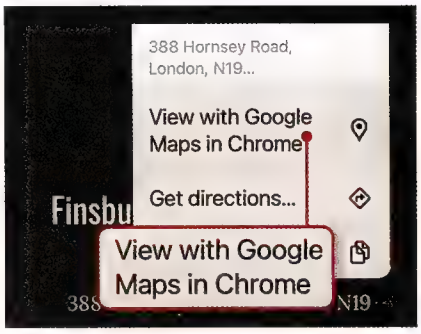
To use the feature, connect both devices to your Wi-Fi network then open WhatsApp on your old phone and tap Settings then Chats. Select 'Transfer chats' (on Android) or 'Chat transfer' (on iOS) and tap Start (see screenshot below left) to generate a QR code. Now choose the same option on your new phone and scan the QR code on your old device to transfer your chats. WhatsApp says that all data is encrypted in transit and includes messages, photos, videos and other file attachments.

Earlier this year, WhatsApp introduced the option to log into your account on up to four additional devices, and sync your chats across them.

iOS

View Google Maps locations in Chrome

Although Safari and Apple Maps are built into iOS, you may prefer to use Chrome and Google Maps on your iPhone or iPad, so you can sync your browsing and mapping data with Chrome on your PC. The latest update to Chrome for iOS (**tinyurl.com/APC524gm**) makes it easier to view locations in Google Maps without needing to open the app – or even have it installed.



Previously, when you selected an address on a web page in Chrome, you'd either be redirected to the Google Maps app or have to copy and paste the details to search for the location. Now you can simply press the address to get the option 'View with Google Maps in Chrome' (see screenshot above right).

Tap this to open a mini Google Maps viewer in Chrome, so you can see how to find the place. However, if you press 'Get directions', you'll still be given the option to open Google Maps or Apple Maps.

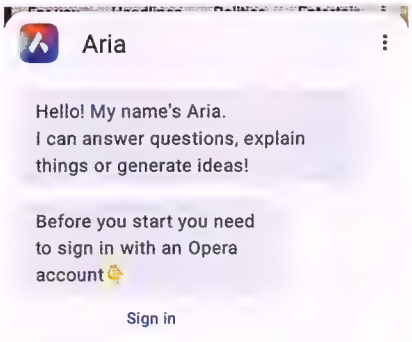
ANDROID & iOS

Try MoneySavingExpert's new AI chatbot

MoneySavingExpert is the latest company to dabble with AI, with its new MSE ChatGPT tool. This 'experimental chatbot' is

BEST NEW APPS

What you should install this month

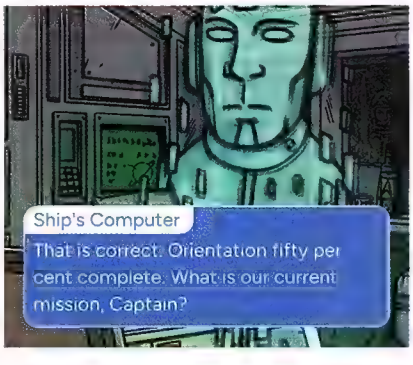

Aria
Hello! My name's Aria.
I can answer questions, explain things or generate ideas!
Before you start you need to sign in with an Opera account
Sign in

OPERA BROWSER WITH AI

Free*

Android tinyurl.com/APC524op

Following the release of its new PC browser, Opera has also updated its Android app. This now includes its AI assistant Aria, which you can launch by tapping your profile icon to ask questions about anything. The browser also offers a VPN, ad blocker and QR code and barcode scanner.



RICHCAST

Free*

Android tinyurl.com/APC524ri

iOS tinyurl.com/APC524riio

RichCast is an 'immersive storytelling app' from the team behind the classic Dizzy series of games. Its interactive stories let you talk to characters using either your voice or by tapping on-screen suggestions, in a 'choose your own adventure' style. There are 30 games to play and you can also create your own.

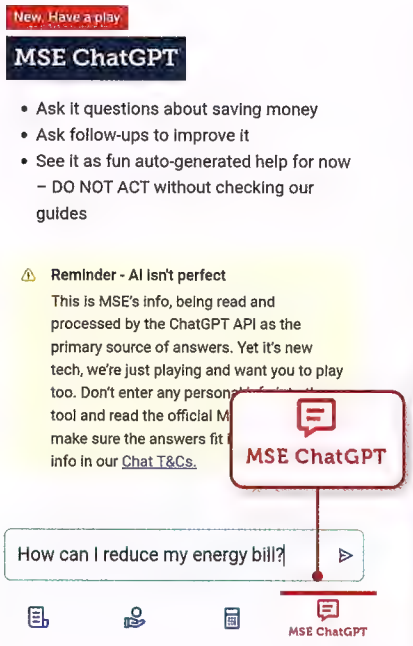
DUOLINGO MATH

Free

iOS www.snipca.com/43943

Duolingo's new app helps kids master multiplication, fractions, decimals, geometry and other maths topics through simple interactive lessons. It also provides Brain Training exercises for adults to improve your "mental mathematics" skills. Choose a difficulty level, set yourself a daily target and start solving sums.

*Contains in-app purchases


New. Have a play
MSE ChatGPT
• Ask it questions about saving money
• Ask follow-ups to improve it
• See it as fun auto-generated help for now – DO NOT ACT without checking our guides
Reminder - AI isn't perfect
This is MSE's info, being read and processed by the ChatGPT API as the primary source of answers. Yet it's new tech, we're just playing and want you to play too. Don't enter any person
tool and read the official M
make sure the answers fit
info in our Chat T&Cs.
MSE ChatGPT
How can I reduce my energy bill?
MSE ChatGPT

now built into the MoneySavingExpert app for Android (**tinyurl.com/APC524mon**) and iOS (**tinyurl.com/APC524monio**) to answer your questions about money matters as if you were speaking to Martin Lewis or another member of his team.

To launch the chatbot, tap the speech-bubble icon in the bottom-right corner of the app (see screenshot above right) and type your money-related question. Once you get your answer, you can ask follow- up questions. The advice is sourced from guides on the MoneySavingExpert website, to save you having to browse lengthy articles to get the information you need (though the tool can't yet link to the relevant guides).

Martin Lewis stresses that MSE ChatGPT isn't perfect and should currently be treated as "fun auto-generated help", but it's a welcome addition to the app.

ANDROID

Find and secure your devices more easily

Google has updated its Find My Device app (**tinyurl.com/APC524find**) with a fresh 'Material You' design and an improved interface that makes it easier to keep track of your Android devices. These include your phone, tablet, Wear OS smartwatch and Pixel Buds earbuds.

When you launch the revamped app, you'll now be prompted to select and sign into the relevant account (if you have more than one). You will then see a list of all the devices that are linked to it. Choose one in the list to view its approximate whereabouts on a map, its current battery level and details of when it was last seen. The updated app also includes a 'Get directions' option to lead you to your device via Google Maps.

If the location is too vague or is unavailable, tap 'Play sound' (see screenshot below) to make the device emit a loud tone – this works even if it's switched to Silent mode.

If your device is lost or stolen, you can lock it remotely by pressing 'Secure device' – you can then set up a password if it's not already protected with one.

It's also possible to erase all data from the device, if you're certain you'll never see it again, by performing a factory reset, but this means you won't be able to track it.

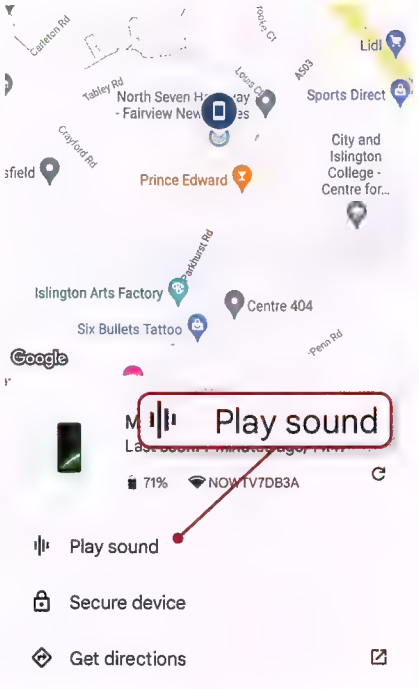
ANDROID & iOS

Check if your passwords have been leaked online

Google has updated its Password Manager in the iOS version of Chrome with a Password Checkup security feature. Already available in the desktop browser and Android app, this warns you if any of your saved passwords have appeared in data breaches, so you can change them immediately.

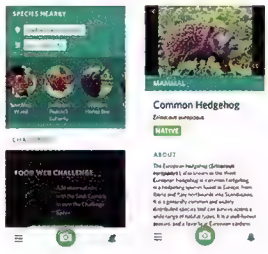
To use the new tool, tap Chrome's three-line menu button, select Passwords and press 'Check now'. Password Checkup will then list any accounts that "use passwords which were exposed in a third-party data breach or entered on a deceptive website". It will also highlight weak and reused passwords.

Select an affected account and tap 'Change password on website' (see screenshot above) to open the relevant site and update your details.



BEST APPS FOR...

Identifying species in your garden



SEEK BY INATURALIST

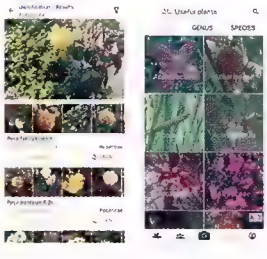
Free **Android** tinyurl.com/APC524se
iOS tinyurl.com/APC524seio

This educational but fun app tells you which birds, insects, plants, fungi and animals are commonly found in your area, then lets you earn badges by taking photos of whatever you encounter. Alternatively, you can just use Seek to identify mystery flora and fauna in your garden and when you're out and about.
Best For: Identifying local wildlife and plants

PICTURE INSECT

Free* **Android** tinyurl.com/APC524pic
iOS tinyurl.com/APC524picio

Despite its nags to pay for a subscription, this app offers an easy way to identify insects, either from photos or by searching its huge database. This spans categories including Common Gardening Pests and Common Biting Insects, and includes images, descriptions and prevention advice.
Best For: Identifying insects



PLANTNET

Free **Android** tinyurl.com/APC524pla
iOS tinyurl.com/APC524plaio

Whether an unknown plant has invaded your garden or you've spotted one that you'd like to grow, PlantNet will identify it from photos of its leaves, flowers or fruit. The app provides information about more than 20,000 species of plant and tree, and lets you browse images shared by its huge global community.
Best For: Identifying plants and trees

PI

Set up a game development system

David Bolton shows you how to set up a Raspberry Pi as a game development machine with a game controller.

This is very much a learning process. Once you've created your first game, it gets a lot easier to do your second and third. We're creating a simplified version of Atari's classic arcade game *Missile Command*.

You have to defend six cities from incoming missiles with your batteries of ABMs (anti-ballistic missiles). Using the mouse, you click a point to intercept a missile and fire an ABM. Once the ABM reaches that point, it explodes, and if the explosion hits the incoming missile, it is destroyed.

As it stands, the game could be expanded on. Here are some ideas of how you could enhance it. For instance, you might give it difficulty levels. Maybe when you start the game the first level only has five missiles. After those are fired, you're on level two and have more missiles. Also, you could increase the difficulty by making the missiles faster. You could have a difficulty multiplier that goes from 1.0 to 2.5 by 0.1 per level. Multiply **xvel** and **yvel** by this and your missiles will move faster.

Another way to make the game more difficult is by reducing the time between missiles being fired at higher levels. A high score table would be nice, too, with score, initials and date saved out to a text file and reloaded each time the game is run.

GENIUS TIP!

Note that the responsiveness of a Raspberry Pi is affected by the quality of SD card. This can be quite confusing but the A-rated SD cards, such as A2, are among the fastest. You don't need the likes of V90, which are better suited for video cameras. A faster SD card means compiles are faster and programs load more quickly.

Going around in circles

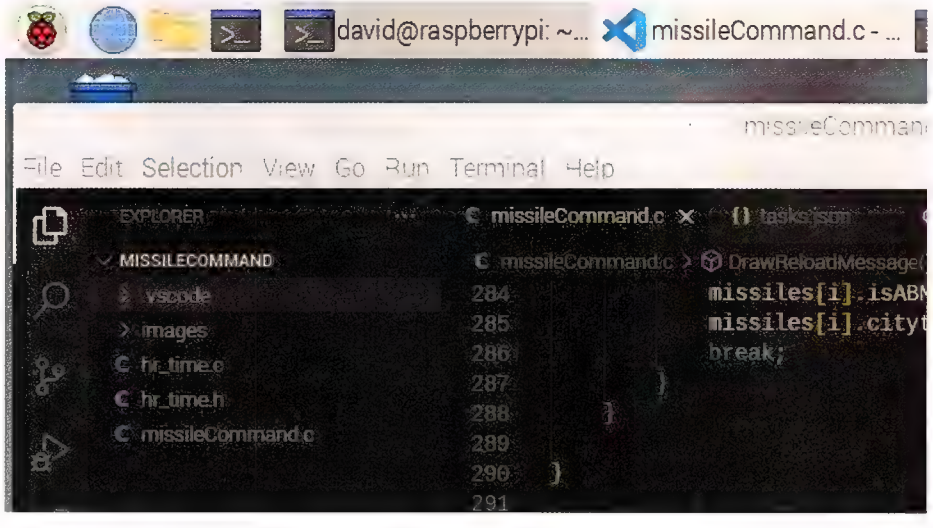
Before you write any code, you need to figure out whether the game can work on your hardware. Arcade games have hardware assistance for sprites and fast graphics. The Raspberry Pi 4B has a GPU, but knowing what it is doesn't really tell you what it can do.

The main game mechanic used is a rapidly expanding explosion and a little experimentation discovered that drawing the pixels as concentric circles with a radius from 2 to 300 took about 0.028 seconds. Drawing everything in a frame should take under 1/60 of a second (0.0167 seconds) so 0.028 is far too slow. The code for DrawCircle() has been left in missilecommand.c for you to look at, but it isn't used in the game.

Plan B

We need to generate 299 bitmaps each with a filled-in circle ranging from 2 to 300 and saved as individual .PNG files. These are included in the GitHub file (see Getting Started boxout). Load all the PNGs at the start of the game into video RAM.

Use the SDL_RenderCopy() function to copy a bitmap for the appropriate size on to video RAM.



The VS Code Explorer view displays the various folders and files.

Copying bytes in the video RAM of a GPU is a lot faster than drawing pixels one by one. Copying the largest bitmap 299x299 takes about 10 microseconds; almost 3,000 times faster than calling DrawCircle() .

Ready player one?

All games have a game loop and everything happens here. For Missile Command this means:

- Generating new missiles and calculating trajectories.
- Reading keyboard controls and setting flags.
- Firing ABMs and calculating the paths.
- Checking if explosions destroy missiles or missiles destroy cities.
- Drawing missiles, ABMs and explosions.
- Drawing the scores and handling the player losing when all his cities are gone.
- Any administrative tasks like managing text flashing.

All this must take less than 1/60th of a second in total – no more than 16.67 milliseconds to run at 60 frames per second. If it takes longer, the frame rate drops and it doesn't look as good.

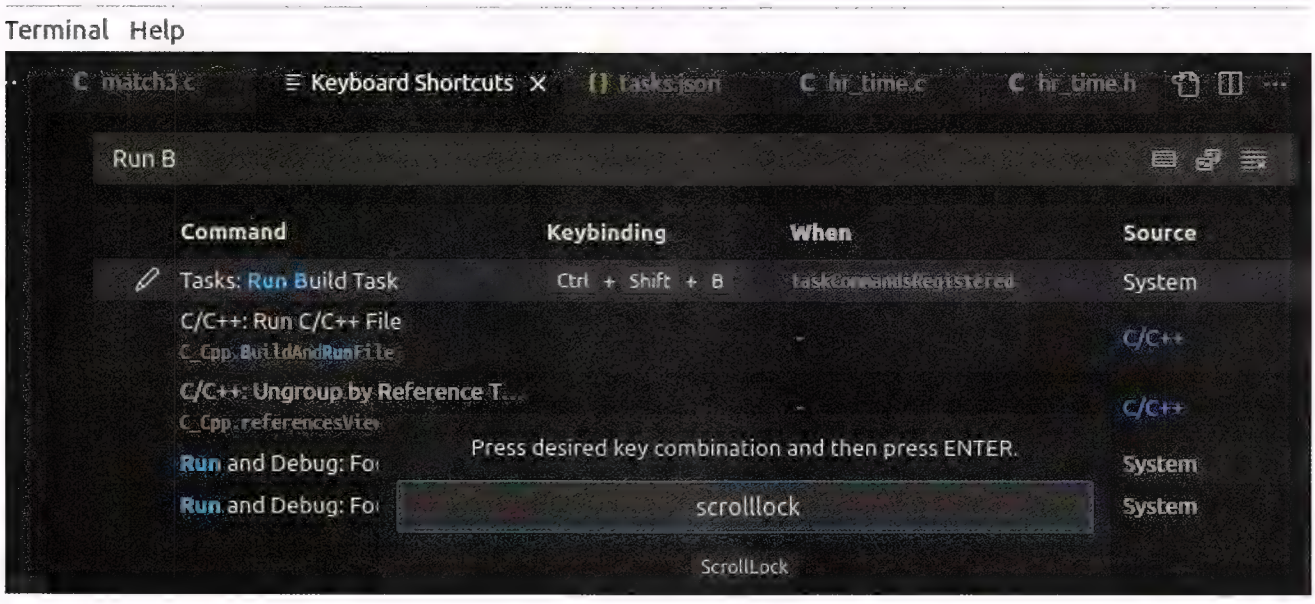
The skill is intercepting one or more incoming missiles. Each city has an ABM launcher with five ABMs. Click anywhere on the screen and the nearest city with ABMs fires one (in black) to that point. Don't waste your ABMs! There's nothing worse than missiles coming in and having no ABMs left.

Game mechanics

Explosions, missiles and cities are held in arrays of structs. Here's the struct for an explosion:

```
struct explosion{
    int y,x;
    int radius;
    int size; // starts at 2 increases to radius
};
```

The array explosions holds 10 of these, so you can have 10 explosions on screen at the same time, including missile explosions. These only have a



small blast diameter of 60, so are quicker to vanish – ABMs have a blast diameter of almost 300. Originally, the size expanded by 1 per frame but that felt too slow, so it's now 3 per frame. This is done in the function ProcessExplosions(), shown here.

```
void ProcessExplosions(){
    for (int i=0;i< MAXEXPLOSIONS;i++)
{
    if (explosions[i].size != 0){
            if (explosions[i].size >=
explosions[i].diameter) {
            explosions[i].size =0; //
finished
            }
            else {
            explosions[i].size+= 3;
            }
    }
    }
}
```

Calculating trajectories

The six cities are placed across the bottom of the screen and are 30 pixels high. The array cities holds six city structs, each with an active flag, the x coordinate of the city and the number of remaining ABMs:

```
struct city{
    bool active;
    int x;
    int abms;
};
```

These are used in the DrawCities() function, which draws them on the screen each frame. It also draws one graphic for each ABM, so you can see how many you have left.

The missiles are fired in the function AddMissile() from row 0 and target row HEIGHT-30. The missile's initial x coordinate is a random number, placing it anywhere along the top of screen. The target x coordinate is the centre of a randomly picked city. It only targets active cities but, because of the time delay between missiles, you can get several missiles hitting a newly destroyed city.

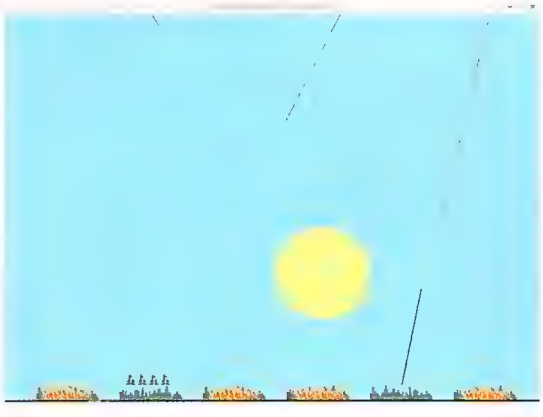
The missile trajectory is a straight line running from (0, initial x) to (height-30, cities x coordinate). This uses a little bit of maths to calculate the x values as missiles and ABMs move:

```
missiles[i].xvel = (float)(cityx-x)/
(HEIGHT-30);
```

To somewhat simplify

The Keyboard Shortcuts window enables you to configure shortcut keys.

Here's the *Missile Command* game – the red lines are missile trails.



GETTING STARTED!

To install Visual Studio Code, browse to **https://code.visualstudio.com/** Download and grab the ARM32 or ARM64 DEB build. Install the DEB and once in VS Code, install the C/C++ extension; the fifth one down is usually the Microsoft C/C++ extension. Click the Install button. Now install Clang with:

$ sudo apt install clang

Install the SDL development libraries with these commands:

$ sudo apt install libsdl2-dev
$ sudo apt install libsdl2-image-dev
$ sudo apt install libsdl2-ttf-dev

To obtain the source code, run:

$ git clone https://github.com/David-H-Bolton/Projects/

You should see the missilecommand.zip file. Now run:

$ unzip missilecommand.zip

This extracts missilecommand.c, hr_time.h and hr_time.c, a folder called images and a folder called .vscode with tasks.json inside. The images folder has all the explosion images, plus city and ABM images.

The JSON file tasks.json includes hr_time.c and links in SDL, SDL_image and SDL_ttf. It's ready to compile. To compile the currently selected file you need to hit Ctrl-Shift-B for Run Build Task. To change that to a single-key compile, hit Ctrl-K, then Ctrl-S. This opens the keyboard shortcuts window.

At the top type **Run b** to filter the options. Double-click on the Tasks: Run Build Task line and then press the key you want in the pop-up window. Try using the Pause key or the Print Screen key. Press the key and then press Enter. After this, pressing that key runs the compile for you.

matters, the yvel (y velocity part) is always 1. The xvel, however, is calculated using the gradient formula xvel = (x1-x2)/(y1-y2). Because all the coordinates are integers, the (float) cast is necessary to make the calculation return a floating-point number.

Each frame, the xvel is added to the float xfract. The int value of this is used for the x coordinate in DrawMissiles(). It uses the SDL_RenderDrawLine() function to draw a line from the start point to the current point.

Firing time

Firing an ABM is almost the same, except the target point is taken from where you clicked and the ABM goes up, so yvel is -1.

Because the movement of ABMs and missiles is almost identical, it makes sense to hold them in the same missiles array. It uses the Boolean field isABM to distinguish between the two types of projectile. You can see this in the function MoveMissiles(), which is where the explosions are initiated by a call to AddExplosion() when the missile or ABM reaches its destination.

AddExplosion() is also called in CheckExplosions(), which looks to see whether any missile or ABM has been caught by an explosion. This uses Pythagoras's equation x*x + y * y = r * r to see whether the distances between the missile and the explosion centre is less than the current explosion radius. If so, AddExplosion() is called, and if it's not an ABM, you get 50 points added to the score.

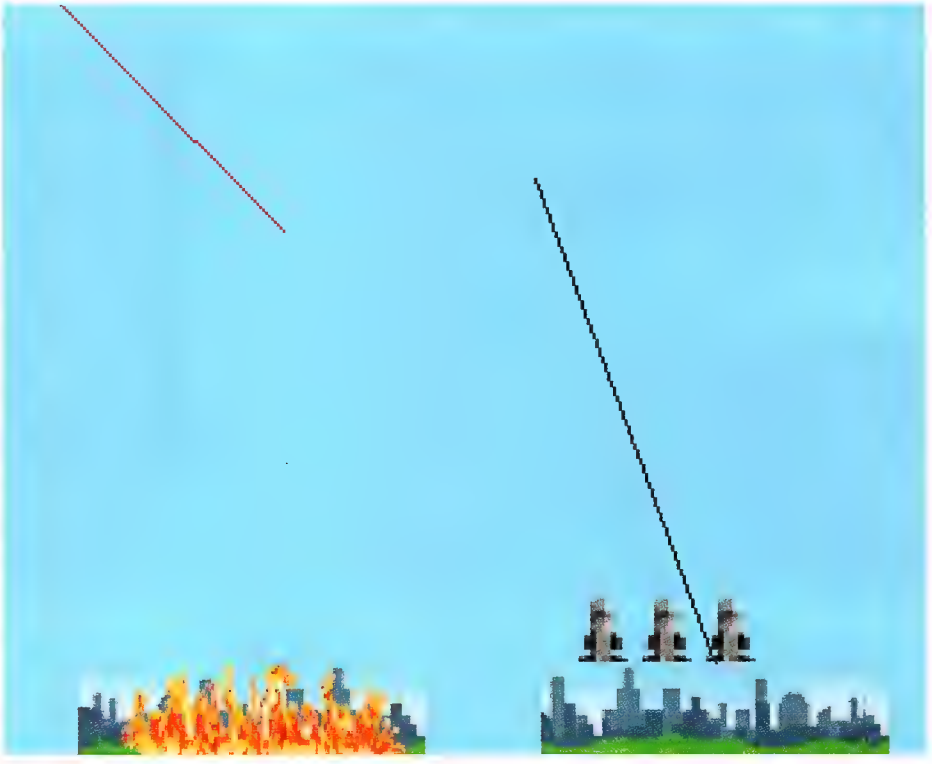
Textify me

There are three places in the game where text has to be output. The first is displaying the score, the second one is when ABMs are reloaded and the third one is when the game is over.

Text uses the SDL_ttf library for handling true type fonts. It uses a font obtained from a free font website: www.1001fonts.com/courier-prime-sans-font.html.

This is loaded into a TTF_Font * variable called font using the following:

```
font = TTF_OpenFont("images/cps.ttf", 20);
```



Missiles (in red) come every 3-3.5 seconds, travelling in different directions and speeds. After every 15 missiles, you get replacement ABMs – they are reset to five for each surviving city.

GENIUS TIP!

Try to limit using printf/sprintf as it can be slow. Sometimes it's inevitable, as in SetWindow Caption(). Try printing into a texture before the game starts and use SDL_RenderCopy to display it.

In the function LoadFont();

All the printing is done in a function called print(), which has the x and y point as parameters. Before calling this, you need to specify the text colour in a variable called textColour. This is of type SDL_Color, which is a struct holding three values for red, green and blue. The colours white, red and blue were used:

```
SDL_Color white = {255,255,255};
SDL_Color red = {255,0,0};
SDL_Color black = {0,0,0};
void print(char * text,int x,int y){
    SDL_Surface *surface = TTF_RenderUTF8_Blended(font, text, textColour);
  SDL_Texture *texture = SDL_CreateTextureFromSurface(renderer, surface);

  SDL_Rect dest;
  dest.x = x;
  dest.y = y;
  dest.w = surface->w;
  dest.h = surface->h;
  SDL_RenderCopy(renderer, texture, NULL, &dest);
  SDL_FreeSurface(surface);
}
```

The print function generates a surface from the font, the text and the text colour by calling TTF_RenderUTF8_Blended(). An SDL_Surface is a block of RAM in the main memory that holds the pixels plus additional information such as size. The original SDL 1 used surfaces for everything but in version 2, textures were added. An SDL_texture is like a surface but the pixels are held in video RAM, which makes displaying them much faster.

The function SDL_CreateTextureFromSurface() converts the surface into a texture and this is copied into the offscreen video RAM using SDL_RenderCopy(). Near the end of the GameLoop() function, a call to SDL_RenderPresent() toggles the display so all the offscreen video RAM becomes visible.

To output text, the sprintf() function prints into a char * buffer. Be careful about calling this too often because it can be relatively slow. It's used for the temperature, but the score uses a faster way to convert a number to a string.

The reason why printf() and so on are slower is that they have to cater for printing different types of variable (such as int, float and char *).

Display counters

Sometimes you want to display messages for a fixed period of time. The easiest way to do this is declare a variable, set it to 60 times the number of seconds, and then decrement it each frame. While this variable is non-zero, display the message.

The reloadCount is used for the ABM reloaded message. After 15

missiles have been fired, reloadCount is set to 120. In the GameLoop(), if reloadCount is greater than 0, it's decremented and the DrawReloadMessage function is called:

```
        if (reloadCount>0){
        reloadCount--;
        DrawReloadMessage();
        }
```

You can get simple effects with counters as well. If you've lost all your cities, the game is over and it flashes **'Game Over! Press r to restart'**. The flashing is achieved by having a variable count up once per frame. When it reaches 60, it's reset to 0. If this counter is less than 30, then a variable flashOn is set true, and from 30-59 it's false. The Game Over message is only displayed when flashOn is true:

```
void DrawGameOver(){
    if (flashOn) {
    textColour = red;
    sprintf(buffer,"Game Over!");
    print(buffer,WIDTH/2-
20,HEIGHT/2);
    sprintf(buffer,"Press r to restart");
    print(buffer,WIDTH/2-
80,HEIGHT/2+40);
    }
}
```

It's a bug hunt!

After playing the game and getting a score of about 20,000, the game crashed with a segmentation error. It was consistent and appeared again roughly around that score.

You can waste a lot of time tracking down bugs like these. They usually happen accessing outside the bounds of an array, not properly freeing up memory, or using pointers without assigning them.

There is only one place where memory is freed: in the print() function. In particular in the DrawScore() routine, which called print() 60 times a second. The DrawReloadMessage() and DrawGameOver() functions also call it, but only for a few seconds.

Allocating and freeing memory 60 times per second for long is not recommended. It fragments memory for one thing and allocating and releasing memory can be slow. If it takes too long, then it could cause the segmentation fault. This was to move the score into the caption:

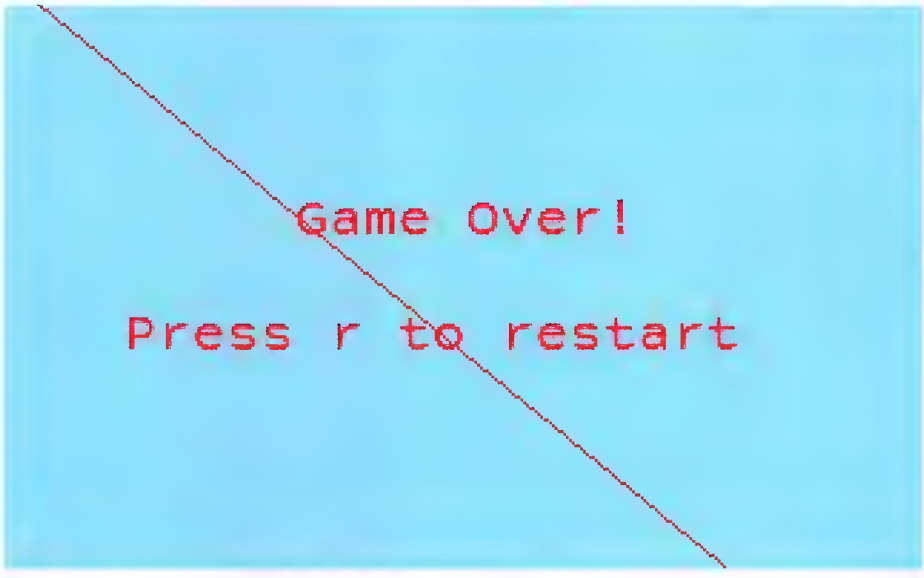
```
void SetWindowCaption() {
    if (debugFlag) {
        if (piFlag) {
            float temperature =
ReadPiTemperature();
            long timing = ldiff();
            sprintf(buffer, "Missile
Command Score 00000 Time = %8ld
Temperature = %3.2f
C",timing,temperature);
        }
    }
    else{
     strcpy(buffer, "Missile Command
Score 00000");
    }
    itoa(score,&buffer[22]);
    SDL_SetWindowTitle(window,
buffer);
}
void DrawScore(){
    if (lastScore==score) return;
    SetWindowCaption();
    lastScore = score;
}
```

This also used a dedicated function itoa() to convert an int to a string and is much simpler and faster. This outputs five characters into a string:

```
void itoa(int u,char * out){
    int tempScore=score;
    int divisor = 10000;
    for (int i=0;i<5;i++) {
    int digit = tempScore/divisor;
    *out++ = ('0'+digit);  // convert e.g.
to '1'1
    tempScore -= (digit * divisor);
    divisor /=10;
    }
}
```

In SetWindowCaption(), both caption strings have 00000 starting at position 22. The function itoa(score,&buffer[22]); overwrites the five 0s with the score. SetWindowCaption() is only called when the score changes, so that helped get the overall time down to roughly 80 microseconds per frame, a fraction of the available 16.66 milliseconds.

A better fix would be to generate 10 textures at the start, one for each digit 0 to 9, then output the appropriate digits for a particular score somewhere on screen. ■



The dreaded Game Over screen, sliced by a missile trail, ready for the next game.

GENIUS TIP!

SD cards can fail. Buy a cheap USB memory stick (or ideally two) and save your source code on to it. That way, if the worst happens, you've only lost the changes since the last backup. Set up a cron job to back up your files.

OPTIMISING CODE

With games, it's vital that you figure out which parts of your code are slow, and make them faster if you can, so you need to time your code. Linux provides a high-speed timer; a Pi 4B CPU runs at 1.5GHz, so the timer counts from 0 to 1,500,000,000 every second.

This timer is read by calling the function timespec_get(&variable, TIME_UTC). To time code, we read the timer twice, once at the start and once at the end, then subtract the two values. The variable returned by this call is a struct with two parts: tv_sec and tv_nsec. The tv_sec part holds the time in seconds, while the tv_nsec part holds the fractional part of a second in nanoseconds.

To use the timer, include the file hr_time.h and call the functions startTimer(), stopTimer() and ldiff(). The ldiff() function returns the time difference between the start and stop times and is accurate to the nanosecond. In the game, the calls startTimer() and stopTimer() bracket the game loop code. You can see the value in the window caption if you press Tab, where the time is a count of nanoseconds. The diff() function returns the time in seconds.

apc HIGHLY RECOMMENDED

GAMES

Aliens: Dark Descent

Taking a more tactical approach to xenomorph blasting.

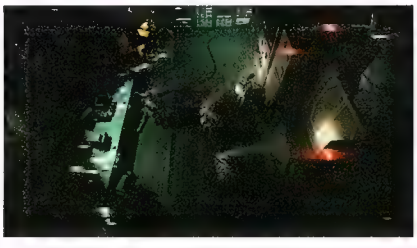
■ $59 | PC, PS4/5, XB1/S/X | focus-entmt.com

Many games have tried to replicate the slow burning tension and chaotic action of *Aliens*, but *Dark Descent* is the first game since Monolith's *AvP 2* to really nail it. Developer Tindalos Interactive has thought intensely about how to get the best out of James Cameron's film in a virtual context, and their solution is a scintillating real-time tactics game that blends stealth, strategy, and nail-biting gunfights.

Dark Descent plays its weakest card first. The game takes place on Lethe, a xenomorph-infested moon owned by Weyland Yutani, and where the Marine frigate USS Otago has the misfortune to crash-land. The cause of the crash is detailed in a story-driven tutorial prologue, but the script is a mess of forced conflicts and awkward dialogue, a draining parasite that plagues the game throughout.

Once stranded on Lethe, the stories you create compensate for the narrative shortcomings. Each mission sees you dispatch a four-person team of Marines to locations around Lethe, either to improve your situation or investigate why the Moon is overrun with bugs.

Unlike most tactics games, you control the entire squad simultaneously, moving them with the right-mouse button and interacting with the left. It



feels odd at first. As you skulk around the mission, exploring buildings and highlighting interactable items with your shoulder-lamp, your motion-tracker in the bottom-right of the screen tracks any movement within 60 metres. Whenever possible, you want to avoid the skittering white dots it highlights, not just because xenomorphs are a bad hang, but because whenever you encounter them, it'll be worse than last time.

Your squad will automatically shoot to keep the creatures at bay, but that alone is rarely enough to stop them. Hitting the spacebar opens up a more elaborate skill menu. Suppressive fire will slow encroaching aliens in a wide cone, while grenades and shotgun blasts are useful for eliminating threats.

Dark Descent's tactical fundamentals are all about knowing when to stick and when to twist. Yet no matter how well you fend off the xenomorphs, there will be lingering consequences. Every attack increases alien aggressiveness, represented by a creeping ticker in the top right of the screen. When this shifts up a gear, not only will more aliens prowl the mission area, they'll also send a massive horde in your direction.

It's a fascinating mixture of ideas with tons of emergent conundrums. This occurs both at the small scale, such as choosing where to set up your defences when an alien onslaught is imminent, and the larger scale, like using a day to return to a previous mission to pick up additional resources and collect those broken sentry turrets you left behind.

A generator of tension and tactical decisions, *Aliens: Dark Descent* is a script pass away from being an all-timer.

Rick Lane

★★★★☆

OXENFREE 2: LOST SIGNALS

The time ghosts haunting the radio waves return.

■ $30 | PC, PS4/5, Switch, Android, iOS, Mac | nightschoolstudio.com/oxenfree-ii

Oxenfree 2: Lost Signals is about adults. It's still a game of criss-crossing a haunted and strange 2.5-dimensional slice of the Pacific Northwest while regularly tuning your radio to Eerie Dead People Talk Shit 102.1FM. It's just that this time the characters being messed with by what might be ghosts or time travellers – or might be both, depending how the wavelength collapses – are less worried about whether a girl thinks they're cool.

The dialogue system was *Oxenfree*'s most notable feature, simulating the way kids shout over each other in movies like *The Goonies*. No one stopped for you to consider which response to choose, and you never knew whether you'd wait until your friend finished what they were saying, or cut them off. Combined with responses that faded quickly if you didn't pick one, talking became a minefield of stress. Which is exactly how it feels when you're a teenager. Even if I didn't end up caring about the individuals in *Oxenfree* as much as I did any given alien in *Mass Effect*, I was totally invested in my awkward attempts to impress them.

> "The dialogue system was *Oxenfree*'s most notable feature, simulating the way kids shout over each other in movies like *The Goonies*."

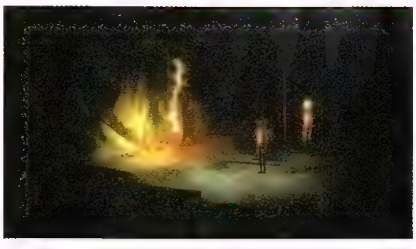
In *Oxenfree 2*, fully adult if not always that mature protagonist Riley has longer to consider her options. She interrupts people less too. *Oxenfree 2* lets you engage in walk-and-talks even when you're alone by giving you a walkie-talkie, and you have to wait for people to say "over" before you have your turn because that's how they work. I did miss out on befriending a radio DJ because I didn't listen to her show at the right time, however. So yeah, it's still easy to miss things. Like the first game, I recommend turning on subtitles.

Oxenfree and its sequel are the kind of horror games you can recommend to people who don't like horror games, more about feeling off-kilter than gore, but when *Oxenfree 2* really goes for it, it's creepy as hell.

Oxenfree 2 from Night School Studio is a mature second run at the walk-and-talk formula.

Jody Macgregor

★★★★☆



apc HIGHLY RECOMMENDED

CHAINGED

You've never played a branching story quite like this.

■ Free | PC | papercookies.itch.io/chainged

The conceit of *Chainged* is a bold one. It starts with Catherine and her daughter Lucy, the latter whisked away by the Antichrist during the apocalypse. After appealing to Chronos, the god of time, Catherine is given two choices where to look, and each takes the form of a new game made by a different developer.

From those two branches multiple timelines diverge, as you play through each game and come to a binary choice. Do you fight the Antichrist or Chronos? Do you save Lucy or the world? As you pick one or the other, you'll be taken to the gorgeous timeline menu, where chains spread from the games like limbs on a tree.

You'll want to play through every timeline, from those first two choices to the multiple endings, and the collection makes it easy with a feature that really all games should have. You can fast-forward to a game's ending choice, and open up a new path without having to play it again. With nearly 40 games included, it makes unlocking every ending an achievable prospect.

A tightly connected anthology that's more than the sum of its parts. This grand experiment yields fascinating results.

Tom Sykes

★★★½☆

SANDTRIX

Tetris hits the beach in this matching puzzler.

■ Free | PC, Mac, Linux, browser
mslivo.itch.io/sandtrix

In *Sandtrix*, the familiar *Tetris* shapes are made of sand, dissolving into particles when they hit the ground. It makes for the weirdest, most inventive *Tetris* yet.

That one key difference aside, the rules of *Tetris* remain the same. Blocks fall and you have to put them into lines, to make them disappear. Here those lines aren't neat rectangles, but hills of coloured sand – connect a colour from one edge to the other, and every touching grain of the same hue will disappear.

The physics make this a special game, as the sand will tumble down those little hills, adding another time pressure and constantly ruining your plans. You almost had a full line of red, but three specks of green have tumbled into the gap. Brilliant, now there's an avalanche of yellow.

It's a lot harder than standard *Tetris*, as you can't just park blocks off to one side for a bit, without them trickling towards you. But when things fall into place, it's a beautiful sight.

The most original thing to happen to *Tetris* in ages.
Tom Sykes

★★★★☆

DAVE THE DIVER

Packed with charm, surprises, and fish.

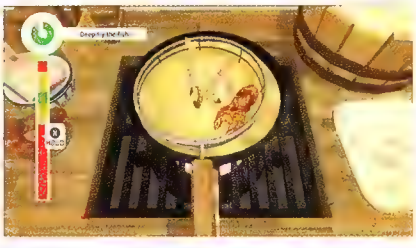
■ $30 | PC, Mac | mintrocketgames.com/en/DaveTheDiver

In 2D pixel adventure *Dave the Diver*, you split your time between spearfishing in a colourful patch of ocean and using the fish you catch in the sushi restaurant you manage. It's simple at first: Each day you swim around impaling fish with a harpoon and collecting crafting resources and other ingredients like seaweed from the reef. The diving is a delight, mostly a chill and soothing experience with colourful fish darting here and there and kelp gently swaying in the ocean currents.

In the evening you put together a menu for your inscrutable sushi chef, Bancho, who makes the meals while you serve a parade of customers in a frantic *Diner Dash*-style minigame. You can use your earnings to redecorate the restaurant and upgrade your diving gear, and as your restaurant grows more popular you can have Bancho research new recipes, which will require new ingredients, which gives you new goals for the next day's dives. The fishing and feeding portions of the game feed perfectly off one other, but things don't stay simple for long.

Nearly every time I sat down to play it threw a new feature or activity at me. Night fishing opens up the pursuit of new. A staff management system for the restaurant lets you hire and train workers to help out. There's a farm to breed fish so you don't have to rely entirely on daily dives, and a farm to grow rice and vegetables for new recipes. As soon as you've gotten comfortable with one system, the game throws a new one on top. There's a comfy daily routine to *Dave the Diver*, but it's constantly growing to incorporate new parts and pieces.

Tying it all together is the stunning pixel art, with roughly 200 lovingly detailed and animated sea creatures, and characters. *Dave the Diver* is a real treat, the biggest surprise of 2023 and hands-down my favourite game of the year so far.



Charming, deep and constantly surprising, *Dave the Diver* is packed with activities and full of heart.
Christopher Livingston

★★★★☆

LAYERS OF FEAR

If it paint broke, don't fix it.

■ $44 |PC | layersoffears.com

Layers of Fear 2023 is, confusingly, both a remake of the original 2016 release of *Layers of Fear* and the 2019 release of *Layers of Fear 2* – with both titles being completely remade in Unreal Engine 5 and smushed together into one cohesive package. The original game was greatly inspired by 2014's PT (the demo for the now cancelled *Silent Hills*) but has a lot more in common, gameplay-wise, with the Amnesia series. You'll be spending the majority of your time carefully skulking through a handful of different haunted locales, gathering clues, solving puzzles, and doing your best not to wet yourself as you're hunted by a series of monsters.

Every story focuses on a different silent protagonist, but the most important are The Painter, a man obsessed with producing the perfect portrait, and The Actor, a disgraced thespian who is hand-picked for the starring role in a new feature film. Each tale takes you to a unique locale, such as an abandoned lighthouse, a dilapidated family home, and a film set on a cruise ship.

"You'll be spending the majority of your time carefully skulking through a handful of different haunted locales, gathering clues, solving puzzles, and doing your best not to wet yourself as you're hunted by a series of monsters."

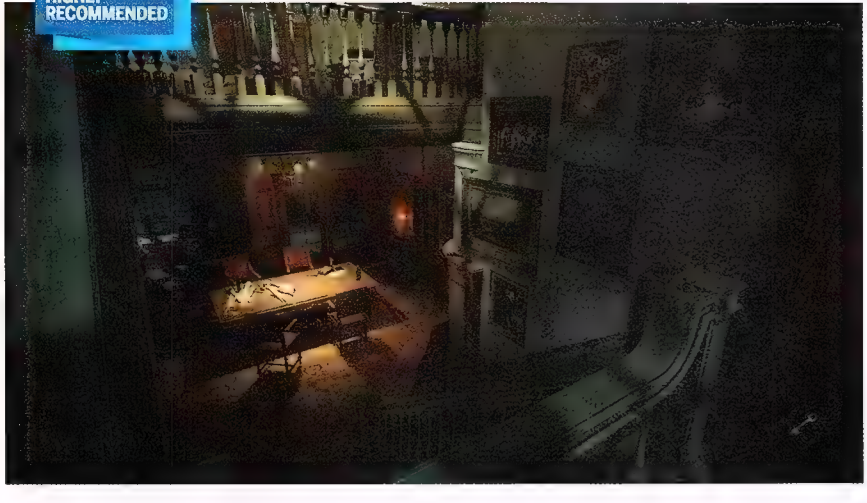
The main change that differentiates the 2023 release of *Layers of Fear* from the original two games is the introduction of an entirely new story, The Writer, which serves to tie all of the original stories present in the first two titles together. Fans of the original *Layers of Fear* will find a lot of the scares have been tweaked in ways that will subvert your expectations and keep the terror fresh.

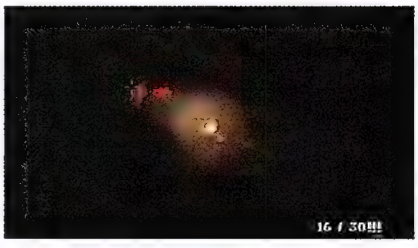
It's hard not to see the stories in *Layers of Fear* as metaphors for the remake's existence. Every story, including the new one created just for the remake, in some way deals with the themes of perfectionism and criticism of art – and remaking these titles has given Bloober Team an opportunity to show everyone how much they've improved since 2016.

Beautiful, horrifying and updated through Unreal Engine 5, *Layers of Fear* is easily Bloober Team's best work to date.

Lewis Parker

★★★★☆





THE PULSE OF EVIL

Sort to survive in this survival horror.

■ Free | PC | bit.ly/PulseEvil

The *Pulse of Evil* is a game about stuff. Glorious weapons and ammo, which you have to cram into your inventory, by dragging and rotating them inside your allotted squares. If I can rotate this shotgun just a little bit, I might rescue a square or two for this crossbow bolt. Ah, and I can fit more pistol ammo if I store them all horizontally. *The Pulse of Evil* has you managing your inventory while in the middle of battle.

You can only carry one thing in your hands in this gloomy top-down survival horror, and to swap your weapon or refill your ammo you have to temporarily drop your weapon into your backpack. Hope you kept a space free for it. Now drag the ammo box onto your rifle before the zombie catches up to you.

What you're doing is clearing out a spooky zombie-infested mine, by traipsing from room to room in search of several fleshy pod-things. Dying throws the player into a new character arriving to finish the job.

A new and thrilling kind of tension that takes box-fiddling and makes it real-time.

Tom Sykes

★★★½☆

GAME CHANGER

Deus Ex: Human Revolution Director's Cut

Fun with robot arms in the self-serious sim. By Ted Lichfield

■ **Release:** August 23, 2011 **Developer:** Eidos Montreal **Publisher:** Square Enix **Link:** eidosmontreal.com

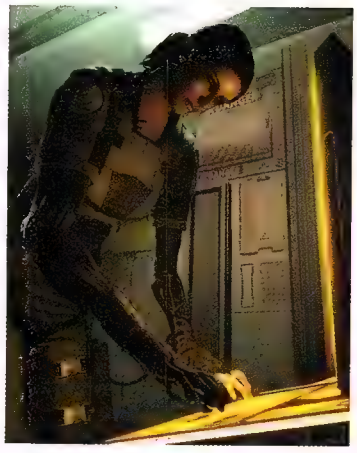
There have been times in my life I've tried to convince myself I didn't like something because it wasn't 'hardcore' or PC enough. For almost a year in high school, I pretended to not like BioWare games – to no one else in particular, just in my own mind palace – because I watched a loud man on YouTube say they were quite bad indeed.

So too, more recently, with the *Deus Ex* series. I played the hell out of *Human Revolution*, Eidos Montreal's 2011 prequel/reboot, in high school. I must have rolled credits on it at least twice before ever making it past the halfway point in the OG classic, and yet for a long time I think I'd subconsciously talked myself into looking down my nose at it: too dumbed down, too different. Give me *Deus Ex*? Yeah, that means Dentons and GEP Guns, I never asked for Jensens or explosive revolvers!

I was definitely still feeling that trepidation when I reinstalled the Director's Cut of *Human Revolution* on my Steam Deck and loaded into its opening sequence. Pre-robot-arms protagonist, Adam Jensen, is preparing to go with his ex-girlfriend and current coworker (yikes, that's a bit awkward isn't it?!) on a trip to Washington DC for her to present revolutionary new research on robot arms. Spoilers for a 12-year-old game to follow, but Megan is actually the worst girlfriend in history and has performed indeterminate, surreptitious human experiments on Adam, who in addition to being an ex-SWAT guy who refused to shoot a teenager when ordered to, is also a very special boy, implied to have been grown in a lab, who can take on robot arms and other, assorted augmentations or 'augs' without rejecting them and needing a drip feed of drugs to cope like most of the population.

Above: *Human Revolution*'s dense, lively environments still impress all these years later.

By the way, those robot arms are like, a super big deal and one of the driving forces of the world economy now. Jensen's boss, David Sarif, thinks robot arms are "the next step in human evolution", Jensen's kinda meh either way and just really down bad for his ex, and Megan's like, super guilty, but not enough to let it impact her career or anything. Anyway, I get a Welcome to Black Mesa-style walkthrough of Sarif's facilities where it's revealed to be a more homey, mom-and-pop supplier of armaments to the US Department of Defense than other robot arm manufacturers like the cartoonishly villainous Tai Yong Medical. Then *Human Revolution*'s diet Foxhound, The



Top right: The office is pretty nice, but what do benefits look like?

Right: *Final Fantasy XXVII* by 2027, we were so naive.

Tyrants, show up, kill Megan (yeah, right), and mess up Jensen bad.

Off the leash

Up till now? So far, so Xbox 360. I got a scruffy ex-military/law enforcement protagonist and his equally boring girlfriend, lightly intractable first-person cutscene, and some stop and pop cover shooting. I was wondering just what I loved so much about this game the first time, and then I made it through all the introductory cutscenes into the first mission.

It's six months after the attack and anti-aug extremists (they're correct!) have broken into David Sarif's main factory to uncover all his dirty laundry, and I'm supposed to go in, rescue the hostages (maybe) and secure any compromising data (definitely). Here, *Human Revolution* gets to one of the Deus Ex series' main selling points: some kind of office or other assorted workplace, after dark, chock full of armed guys to knock out and hide in vents, peoples' emails to read, and hidden paths to take.

I was hooked – I didn't even mind that I missed the hostages partway through and had to redo half the level to save them. One of the big things that's hitting me about jumping right into *Human Revolution* after a playthrough of *Deus Ex* is how good *Human Revolution* feels. Rough edges grip me, and the ambition and open-endedness of games like *Deus Ex* or *System Shock 2* is something I'll defend to the day I die, but the way Human Revolution presents a more consistent, smooth, approachable stealth game in wide open levels reminiscent of the original was an absolute masterstroke.

Look at the stealth takedowns, for instance. In the original *Deus Ex*, non-lethal knockouts are best achieved by tapping someone with the riot prod once to stun them, then either prodding them again, wasting valuable ammunition, or by switching to the police baton and smacking the enemy precisely in the midsection. Anything else, and they start yelling for help and

TOP TOOLS

My favourite augs in Human Revolution

ICARUS LANDING
Take no falling damage whatsoever, and you also get a fun animation and area of effect stun ability if you fall from high enough. Great for really opening up your traversal options.

JUMP HEIGHT
Adam Jensen's pitiful two-inch vertical gets replaced with the sort of floaty leap I've come to expect from Master Chief. Coupled with some strategic crate-stacking, you can reach dizzying heights.

DOUBLE TAKEDOWN
A little finicky with its targeting sometimes, but usually if you see two guys and press the takedown button, you'll pull some brutally satisfying The Raid-style martial arts action and leave 'em both out cold.

SUPER STRENGTH
Particularly good for a laugh when in one area a guard complains of almost having a vending machine fall on him, and you can then go around the corner, pick up a vending machine, and throw it at him.

Top left: There's nothing quite like *Human Revolution*'s gold neo-renaissance.

Left: I'm in a Blade Runner kinda mood.

shooting at you. If I upgrade my Low Tech weapon skill all the way, I can knock some enemies unconscious outright with just the baton sometimes, while high-level enemies like MJ-12 Commandos will ignore my riot prod about 50 percent of the time.

In *Human Revolution* I tap the takedown button and watch a fun little cutscene of Adam Jensen going full John Wick mode at whoever I'm looking at, with this ability only limited by a clear resource, my little aug batteries. That consistency extends to detection: in the original game, I find I can crouch walk mere feet in front of certain enemies without being detected, while in other instances I've had bullets start flying at me from halfway across a map because of a guard I could barely even make out. Meanwhile, *Human Revolution*'s guards always behave fairly reliably, and I quickly got used to the limits of their vision. There's a place for both approaches, I think, but *Human Revolution*'s take on a stealth-focused immersive sim isn't dumbed down, it just goes down smoother, and I can always be secure in the knowledge that an enemy alert was my fault.

Hub bub

Human Revolution comes even more alive with its non-combat zones, and this is definitely an area of genuine iteration on the original game. Detroit and Hengsha are just as complicated as Hong Kong or Paris from *Deus Ex*, chock full of sidequests, optional encounters and weirdos' apartments you can just break into and watch TV in. *Human Revolution* then benefits from the multi-generational leap in graphics technology, with so many of its interiors just feeling cluttered, characterful, and lived-in. A fantastic game to hang out in and explore.

I spent a solid hour and a half or so just bumming around Sarif HQ after that first mission. There's almost a dozen offices with emails to read and goodies to purloin, while at this point in the game I can only brute force hack the doors to a handful of them. Most, however, have their codes squirrelled away somewhere in the building, and I felt like I was untying this tightly wound knot as I opened up more and more offices, hoovering up goodies and snooping on emails to get a sense of what this place is like during the day.

Augmented Reality

I'm getting more comfortable with just loving *Human*

BEST BUDS

I love Human Revolution's characters

MALIK
Your 100% dependable best bud. Can potentially die in a tense sequence toward the end of the game, and if you don't break your 100% stealth/pacifist run to gun down the mercs coming for her, you may not have a heart.

PRITCHARD
This jerk is your nerdy hacker mission control. Hates your guts at first, but warms up to you. Has a *Final Fantasy XXVII* poster hanging in his office, Square's gotta pick up the pace to release ten more entries in the next four years!

SARIF
Your whiny, loser boss. Sarif signed off on human experiments on you, thinks robot arms will change the world, pulls a real "you and your dad just tossin' the pigskin" routine that's paper thin. Even still, I kinda like the dork.

Honestly? I've seen better cyberpunk clubs than The Hive.

Revolution's gameplay, characters, and vibe while also asserting my truth: this game is dumb as hell, man. The original *Deus Ex* is ten years older and has a vision of the future that remains gripping and prophetic – I think that game is more than due a *Metal Gear Solid* 2-style reappraisal as a genuinely great work of sci-fi.

In *Deus Ex*, all the goofiness around '90s conspiracies – greys, mole men, and the like – belies a razor sharp, cynical view of the coming century. The pursuit of profit and power has become decoupled from production and good governance, leaving society spiralling in the face of myriad crises like a mysterious plague, economic collapse, and climate change. The government can only punish its citizens and wage war, not proactively solve any of its issues. Weirdly, however, no one treats it like the end of the world. Everyone goes to their jobs, reads the paper, hopes for things to get better as the situation degrades, the fever never seeming to break. Does any of this sound familiar?

Human Revolution, meanwhile, boldly asks, "What if everything revolved around robot arms?" My colleague, Joshua Wolens, pointed out to me how much it feels like Eidos Montreal just hyper fixated on the original game's tertiary concern around augmented agents. As we approach Human Revolution's setting date of 2027 with dizzying speed, it starts to feel more like a *Fallout*-esque, over the top, themed alternate reality than any kind of sober prediction or pointed reflection of our own times. *Human Revolution*'s very self-serious presentation covers up what I've found to be supremely goofy science fiction conceits.

> "David Sarif thinks robot arms are "the next step in human evolution""

Compare all the human augmentation stuff to real-life cosmetic surgery or AI concerns and it's almost laughable: of course this crap should be regulated, man! In-game though, the anti-aug movement is coded as this dorky, retrograde 'mothers against videogame violence' deal, before getting upgraded to weird, sort of sci-fi racists in the sequel. Anti-aug leader Bill Taggart smacks of some kind of *Moral Majority* lickspittle opportunist, while the whole movement has been astroturfed by the Illuminati to... do something? I guess they want to control 'human evolution' as David Sarif has dubbed chopping off a guy's arms and legs to give him robo strength.

But you know what? I've come to love it the way I do a JRPG plot. *Human Revolution* is goofy, fun sci-fi themed around robot arms and pining for your ex-girlfriend who did human experiments on you, as far removed from *Deus Ex*'s sharp, thought-provoking sort of sci-fi as the Star Wars Expanded Universe (sorry, I meant Legends).

There's room for both types of *Deus Ex* in my heart, and I think it's finally time for me to dig into Eidos Montreal's follow-up, *Mankind Divided*. ■

RETRO

The inside story of Compaq's portable clone

Forty years ago, Compaq broke IBM's dominance by creating a portable computer that ran all IBM PC software. Co-founder Rod Canion tells David Crookes how it was achieved.

Computers cannot survive and thrive in isolation. They need software and lots of it to make them practical and useful. History is littered with machines that appeared to be promising on the face of it yet were let down by a lack of support from software developers. With too few apps, consumers would shy away from making a purchase and, with too few consumers, developers would decide their efforts would be better rewarded elsewhere.

When three former Texas Instrument (TI) workers decided to set up their own business and manufacture a computer, they were acutely aware of the problems that such a vicious circle posed. It was the early 1980s and there was no computing standard. Developers needed to tweak their software to work on various machines and they would prioritise their work based on the size of the different user bases.

The situation meant entering the computing industry as a newbie manufacturer was tough, particularly so when targeting the business market. Fail to attract software such as the first spreadsheet program, VisiCalc, for instance, and the company was likely to go bust. But what if a computer manufacturer could tap into another machine's vast library of software? Surely that way its computer would end up being well supported from day one.

Above: Rod Canion proudly shows off Compaq's portable PC.

> "It was the early 1980s and there was no computing standard. Developers needed to tweak their software to work on various machines and they would prioritise their work based on the size of the different user bases."

Such was the approach made by Compaq – and it had an impact far beyond the co-founders' expectations. By creating the first fully IBM-compatible portable computer, the fledgling company helped to shatter IBM's dominance of the PC market. Not bad going for three people who had left their jobs at TI without much of an idea

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of what to do next.

Here, we speak to one of Compaq's co-founders to find out how they did it.

DOSing around

Rod Canion, Jim Harris and Bill Murto were senior managers at TI, but they'd grown disillusioned with life at the semiconductor manufacturer. They yearned to create a company that promoted trust and satisfaction, so they worked on a business plan, explored potential funding avenues and created a startup called Gateway Technology, all while looking into product areas that interested them.

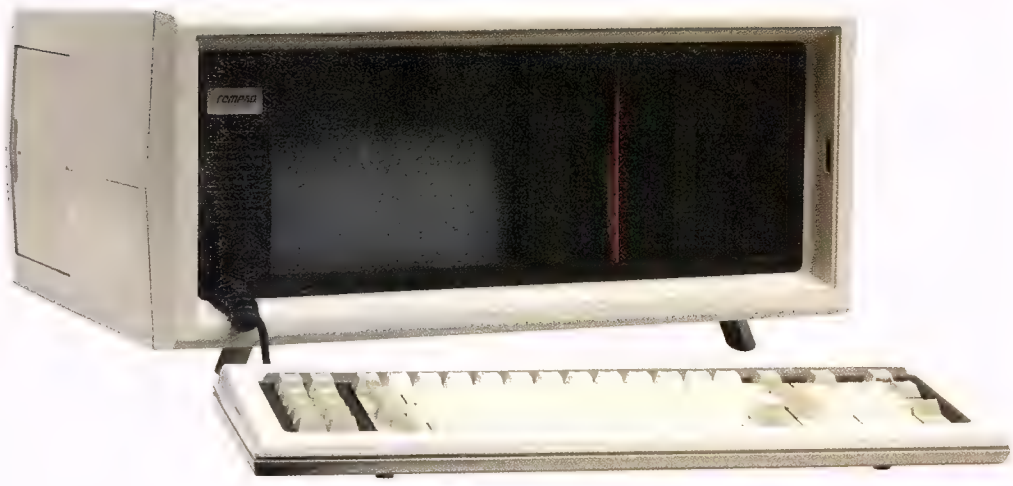
"We'd worked together for more than five years in our respective roles in starting up new businesses inside Texas Instruments," Canion told *APC*. "We were excited about the opportunity the growing demand for PCs represented and, at the same time, were frustrated at the over control coming from TI management.

"When IBM entered the market in August 1981, we could see that the PC industry was going to explode so we decided to launch our boat and start paddling. All we knew then was that we were going to find a need in the industry and fill it." The trio spent six weeks brainstorming ideas without success but then, on 8 January 1982, inspiration struck.

Canion was drinking coffee, thinking about portable computers. By this time, a few had entered the market, most notably the first commercially successful machine, the Osborne 1 in 1981. This was based around the Zilog Z80 processor and, as well as having a 5in monochrome CRT display, it ran the CP/M 2.2 operating system for which lots of software had been created. Canion reckoned Gateway could do better.

"In 1981, there were a lot of portable computers on the market, but none of them were styled professionally nor were they rugged enough to be carried on an aeroplane," Canion explained. "Our first thought was that we could fill a need with one that was both, but we also knew that, with more than 200 computer companies coming to market with PCs, there was no way we were going to get software adapted to our product.

"There were just too many different companies competing for, say, Visicorp's limited resources, so only the biggest companies would be successful in obtaining software such as VisiCalc. Of course, IBM and Apple would get the first versions from every software company." Yet, with IBM being the personal computer industry's market leader, a golden opportunity presented itself.



The Compaq Portable was groundbreaking, but it didn't come cheap.

Since August 1981, MS-DOS had been gathering momentum. Microsoft had licensed it to IBM, which offered it as PC DOS while different versions were being licensed by dozens of other companies. Canion reckoned buyers would swoop on a portable computer that, on the one hand, used the IBM version of MS-DOS and, on the other, ran software written for the IBM PC. However, this meant the portable would need to be fully IBM compatible.

"We had the idea to make our product run the exact same software as the IBM PC," Canion said. "We weren't trying to copy the IBM PC, but we did want to have all the popular software available for our portable. Whether we could legally make that happen was the 100-million-dollar question. We convinced our investors that we could, but it turned out to be a lot harder than we originally thought."

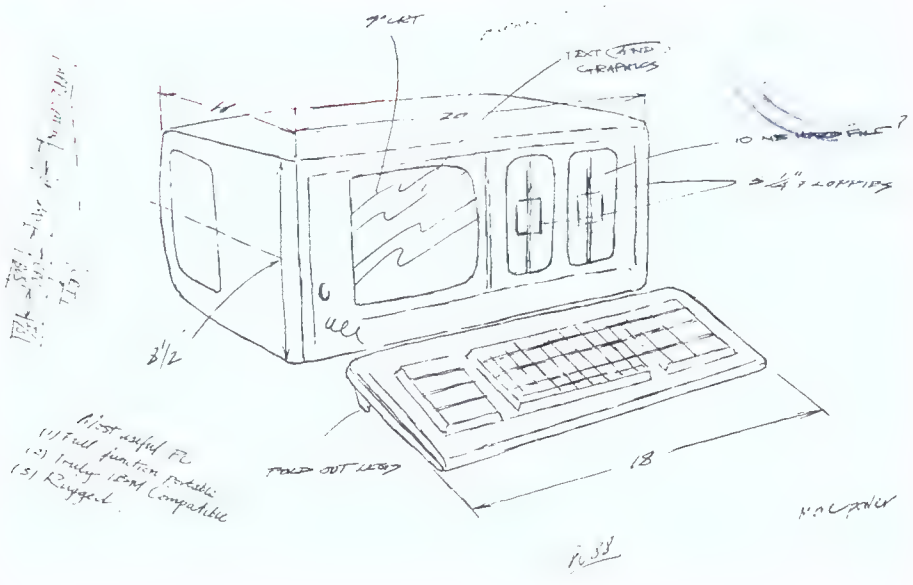
Better ingredients

To attract investment, Harris and Canion wrote a product description, explaining why their computer would be different to the Osborne 1. The key idea was to make their machine look and operate like an IBM PC, even if they weren't entirely sure at this stage how it would be accomplished.

To help communicate the concept, Harris called Ted Papajohn. "We had known Ted from his days at TI as an industrial designer and we wanted to have a sketch of the portable we wanted to build for our business plan," Canion explained.

"We believed that it needed to be professionally styled to look good in an office environment. So

Compaq was to become a major player in the PC world thanks to Canion.



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A reproduction of Ted Papajohn's sketch of what became the Compaq Portable.

we asked Ted to meet us at a Computerland store in Houston to show him the IBM PC and the Osborne 1. After looking over these products at Computerland, we walked next door to the House of Pies to sketch out the product.

"One of the important things was to have the keyboard identical to the IBM PC so someone running software designed for the IBM PC would have no trouble operating the same software on the Compaq Portable. After Ted sketched it on the back of a placemat, we knew that it was the way the product should look. It was a thrilling feeling to see it for the first time."

With a sketch, a four-page business plan and a product description in the bag, the company co-founders met with former TI engineer LJ Sevin and Morgan Stanley technology analyst Ben Rosen. They were partners in the venture capital firm Sevin Rosen Funds and they sent Canion and Harris to meet with venture capital firm Kleiner Perkins Caufield & Byers in San Francisco. "Two weeks later, we had a funding commitment for $1.5 million," said Canion. Gateway Technology was then incorporated on 16 February 1982.

Canion and Harris had long resigned from TI by this point. Murto resigned a little later, but all were ready to hit the ground running with Gateway by the time the funding was in place. "We began hiring engineers and programmers to start the process of figuring out how to reverse-engineer the IBM PC," Canion said. "As soon as word got around that we had started a company, people we had worked with at TI started contacting us to apply for a job."

Among them were electrical engineers Steve Ullrich, Ken Roberts and Gary Stimac, all of whom were very highly regarded. Stimac was tasked with buying an IBM PC from a store in Dallas, and he became very excited when he saw that the IBM BIOS ROM code was printed in the manual.

Clean room

Unfortunately, looking at that code was a mistake. It meant Stimac wouldn't be able to work on any of the BIOS code for the proposed computer – if he did, IBM could claim that he'd been influenced by its work and that would put the whole project in murky legal waters. "We didn't copy IBM's code because it was illegal and would have resulted in being shut down," Canion said. "We were fanatical about getting good legal advice and then following it totally."

Instead, another engineer, Steve Flannigan, was given the task of writing the BIOS code. The team was also bolstered by engineers John Reilly, Walt Russell and Bill Bray and, slowly but surely, the project came together with the team doing all they could to iron out incompatibilities with the IBM PC. For Gateway, nothing but full compatibility was acceptable. Other computers were coming to market claiming to be compatible with the IBM but, in reality, they were falling short.

One of the biggest problems was licensing an MS-DOS version that was compatible with PC DOS. Due to the way it had been created (in conjunction with IBM), Microsoft would have to reverse-engineer PC DOS, and it wasn't going to start burning bridges with such a big partner.

The best Microsoft could do was allow Gateway to use a version that was as close to PC DOS as possible, yet that meant Gateway would have to fix any compatibility problems itself (although Microsoft did lend a hand). Meanwhile, the engineers were still hard at work on creating an early working prototype. They were nailing down some of the key design features, although the process didn't always run smoothly.

"One of the features we'd planned for our portable was a display that could do both high-resolution text for word processing and graphics for graphs and drawings," Canion explained. "IBM required two different display boards and monitors to do both, so we went down the path of making our display switchable between the two.

"It was giving us trouble, though, and we had a critical demonstration planned for early June 1982 when the National Computer Conference was to be in Houston. The night before the demo Ken Roberts and others stayed up trying to get it to work and I stayed up with them to help wherever I could. They finally got it working and it turned out to be a key feature. We impressed the dealers, press and investors we showed it to by demonstrating something no other computer could do at the time."

With interest rising as the weeks went by, Gateway hired more staff.

With the keyboard stored neatly away, the computer could be easily carried.

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The new members would help to speed up the process of coding the ROM BIOS and writing a compatible version of MS-DOS. Around this time, Gateway also changed its name to Compaq and, by November, the company achieved its objective. It finally had a fully compatible portable PC capable of running all IBM PC software. As *Byte* magazine reported in January 1983, having tried a prototype, the "interesting approach to duplicating the functions of the IBM PC, as well as the overall quality of the machine, is a testament to the designers' engineering expertise".

The Compaq Portable was certainly impressive. It had a 4.77MHz Intel 8088 CPU, 128KB RAM and could be configured with one or two 5.25in floppy disk drives. It also featured a CGA-compatible video card and a built-in 9in green-screen monitor. Costing $2,995 for a basic system, it wasn't cheap, but it weighed a then modest 12.7kg and could be carried by a handle.

For business people on the move, it proved ideal. "To transport it," *Byte* wrote, "you simply secure the keyboard to the main unit by locking two sliding latches." There was a sliding door for storing the power cord and another to reveal expansion slots. Just as importantly for a computer designed to travel, it was built to withstand knocks.

"Jim Harris was shown a prototype one day in his office and he asked the engineers if it was rugged enough. They replied that it was," Canion remembered. "So he picks it up, walks out into the hall and tosses it down the corridor. It cartwheels along with parts flying off in all directions. Jim turns to the engineers and tells them to go make it rugged!"

Deal or no deal

Although the computer appeared to be a technological success, Compaq's work wasn't done. The next step was ensuring people could actually buy the computer, but it was tough going initially. "Bill and I were going showing dealers our product but they were being deluged with other PC companies getting them to carry their product, too," Canion said. "It was hard to get an appointment with someone to show our product to."

When they did get through, the pair would describe the product features and capabilities and, at the end, tell the dealers that it would run all of the software written for the IBM PC. "They were always sceptical, so we told them to pick any package off the shelf and try it out," Canion said.

The Compaq Portable Plus was released in 1984, adding a hard drive.

"When the software they had picked came up and ran, their eyes got big, they thought for a moment, and then asked how soon they could get five, ten or even 25 of them. Every dealer we talked to did the same thing. The big surprise was that we had invented the solution to a very big pent-up demand for a portable version of the IBM PC."

This, however, caused a problem. Demand threatened to exceed supply. "Back in Houston we met with our team and decided we had to increase our production ramp in order to meet the demand," Canion said. "We raised an additional $20 million in February of 1983 to fund the rapid expansion. We also signed all of the important computer dealers who sold the IBM PC to carry our product."

By the end of 1983, the Compaq Portable remained the only third-party computer that ran all IBM PC software, and it sold 53,000 units in its first year. The dealers were also taking the company very seriously indeed. Back then, dealers believed they could only carry three or four PC brands – IBM and Apple were seen as a given. "But when we took up the third spot, there was only one spot left to be fought over by 200 companies," Canion said. "We went public in December 1983 and raised $66 million. At that point the first leg of the race was decided."

> "By the end of 1983, the Compaq Portable remained the only third-party computer that ran all IBM PC software, and it sold 53,000 units in its first year."

Of course, IBM – rocked by the fact another manufacturer had managed to muscle in on its dominance – wasn't going down without a fight. In February 1984, it introduced its own portable PC, and everyone expected it to knock Compaq out of the market. "At first, orders for our product stopped completely and we were faced with a critical decision of whether to cut back on production, drop our prices or both," Canion said. "Instead, we kept building new computers at full speed and waited to see the market's reaction."

Two weeks after the IBM announcement, orders started pouring into Compaq and it was able to enjoy a record quarter. "IBM stopped producing its portable two years later," added Canion. Compaq, meanwhile, went from strength to strength. Strong relationships with Intel and Microsoft, a host of new portables and desktops as well as a leading role in the creation of a new PC standard (EISA) would prove revolutionary. But that's another story for another time. ■

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CHIP CHAT

JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS

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GOOGLE USES AI TO TLDR THE ENTIRE INTERNET

SEARCH LABS IS USING BARD TO SPOON FEED YOU THE ANSWERS TO ALL YOUR QUESTIONS.

Google is implementing a new AI-powered article summarisation tool that will save you the toil of reading. The experimental Search Generative Experience was detailed in a company blog post as "specifically designed to help people more deeply engage with long-form content from publishers and creators", by conveniently transforming it into a short form answer. It's great to see Google catering for those of us that would prefer reading and thinking to be optional extras in our internet browsing habits, but we do worry about the technology's capacity for summarising factual content accurately. It's not like AI (or even Bard itself) has a great track record for sticking closely to the truth.

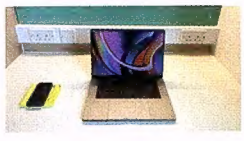

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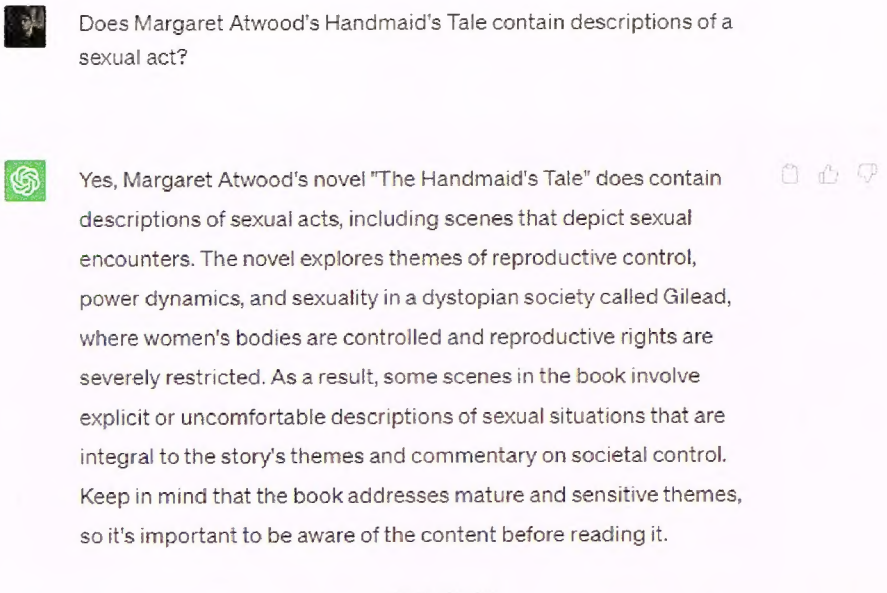
Figure 6: Desk setup for recording keystrokes

AI CAN DECIPHER WHAT YOU'RE TYPING FORM THE SOUND OF YOUR KEYBOARD

UK RESEARCHERS TEACH SOFTWARE TO HEAR WHAT YOU'RE TYPING WITH IMPRESSIVE ACCURACY.

The clickety-clack of a mechanical keyboard is generally the kind of thing you'd associate with a master hacker, but from now on it'll only be sloppy and out-of-touch coding geniuses using obnoxious Cherry Blues thanks to a new piece of AI software that can decipher information from the sound of your typing. Researchers form Durham University in the UK were able to develop a deep learning tool that can decipher typed information with 95 percent accuracy using just audio recordings. The paper does highlight a few mitigating techniques like using the Shift key and refraining from using words in your passwords.


Does Margaret Atwood's Handmaid's Tale contain descriptions of a sexual act?
Yes, Margaret Atwood's novel "The Handmaid's Tale" does contain descriptions of sexual acts, including scenes that depict sexual encounters. The novel explores themes of reproductive control, power dynamics, and sexuality in a dystopian society called Gilead, where women's bodies are controlled and reproductive rights are severely restricted. As a result, some scenes in the book involve explicit or uncomfortable descriptions of sexual situations that are integral to the story's themes and commentary on societal control. Keep in mind that the book addresses mature and sensitive themes, so it's important to be aware of the content before reading it.

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CHIP CHAT

ChatGPT used to ban school literature that Republicans don't like

Iowa enlists AI to help blacklist books that mention sex for all students up to year 12.

The Mason City School District, Iowa, has used AI to identify curriculum books that contain "a description or depiction of a sex act" in order to enact a new Republican-backed education law that was introduced in May, 2023. The school district removed 19 books from its catalogue using ChatGPT, according to an interview by *Popular Science* with Assistant Superintendent of Curriculum and Instruction, Bridgette Exman. ""Frankly, we have more important things to do than spend a lot of time trying to figure out how to protect kids from books," said Exman, noting that the district also had a duty to comply with all local laws.

MUSK SLOWS TRAFFIC FROM X TO SITES HE DOESN'T LIKE

X imposes delays to a select group of sites that Elon 'coincidentally' hates.

According to a report by *The Washington Post* in August, the questionably renamed social media company X (formerly Twitter) was slowing traffic from its platform to a number of competitors and news orginisations that owner, Elon Musk, has publicly criticised. While the controversial policy was wound back just hours after the *Post*'s initial article, the publication was able to determine that X was throttling links from its platform to Facebook, Instagram and the *New York Times*, among many others, using the t.co domain that shortens links for the micro-blogging site. Neither Musk nor X responded officially when asked for a comment on the 'systemic' 5-ish second lag to particular sites. ■

Mario Nawfal @MarioNawfal · Jun 21
META to Release "Twitter Rival" Called THREADS
(not making this up!)
META, the same company that copied Snapchat, TikTok, StumbleUpon, Foursquare, BeReal and Clubhouse, began coding 'Project 92' three months after Elon acquired Twitter.
Rumors have been circulating about the... Show more
2,210
1,883
8,797
5.1M
Elon Musk @elonmusk · Jun 21
Subscribed
I'm sure Earth can't wait to be exclusively under Zuck's thumb with no other options.
At least it will be "sane". Was worried there for a moment
1,185
1,389
17.8K
1.1M
frankenbeans @kiwimarkoff26656 · Jun 21
Better be careful
I heard he does the ju jitsu now
42
53
891
182K

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